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ABSTRACT

Man and the Biosphere Program is an interdisciplinary program of research which emphasizes an ecological approach to the study of interrelationships between man and the environment. It is concerned with subjects of global or major regional significance which require international cooperation. This final report discusses areas in which international research projects need to be conducted. (Author/CP)

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International Co-ordinating Council of the Programme on Man and the Biosphere (MAB)

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Session

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I. INTRODUCTION

1. In accordance with resolution 2.313 (see Annex) adopted by the General Conference of Unesco at its sixteenth session, the first meeting of the International Co-ordinating Council for the Man and the Biosphere Programme was held at Unesco House in Paris, from 9 to 19 November 1971. The statutes of the Council are given as an Annex.

2. The meeting was opened by Mr. J. Fobes, Deputy Director-General of Unesco. He welcomed the participants and read the message of Mr. René Maheu, Director-General of Unesco, who was unable to be present at the meeting of the Council. In his message, the Director-General reviewed some of the major scientific activities of Unesco, both past and current, and pointed out the high importance given to the Man and the Biosphere Programme by the Organization. He underlined that the Man and the Biosphere Programme by no means represents the totality of Unesco's involvement in environmental problems, and that the Council might valuably concentrate its discussions on those topics of direct relevance to the Programme itself, and to the particular machinery which had been set up for it. In considering the duties of the first session of the Council, the Director-General indicated that in first priority it should define the main lines of a flexible scientific programme based on the desires of the Member States, focusing on a small number of useful and realistic projects, in which a large number of countries, whatever their situation and level of development, could profitably take part. He added that the Council should also consider the ways and means through which recommended projects would be implemented, including the establishment of the Working Groups of the Council and panels of experts. He mentioned that the recommendations of the Council would be immediately communicated to the Member States and interested international organizations, for appropriate action. (The full text of the Director-General's message is given as Annex I.)

3. The Council elected the following officers to constitute its Bureau:

Chairman
Mr. F. Bourlière (France)

Vice-Chairmen
Mr. D. R. King (U. S. A.)
Mr. V. Kovda (USSR)
Mr. M. A. Kassas (Arab Republic of Egypt)
Mr. R. Misra (India)

Mr. di Castri of Unesco acted as Secretary of the meeting, assisted by Messrs. Eckardt, Fournier and Hadley.

4. From the 25 members of the Council, the following 24 members were represented at the session:

Arab Republic of Egypt	Italy
Argentina	Japan
Australia	Malaysia
Brazil	Netherlands
Canada	New Zealand
Czechoslovakia	Nigeria
France	Romania
Federal Republic of Germany	Sweden
India	Uganda
Indonesia	Union of Soviet Socialist Republics
Iran	United Kingdom
Iraq	United States of America

5. In addition, observers from the following Member States were present:

Austria	Hungary
Dominican Republic	Israel
Finland	Norway

The United Nations (UN), including the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO), the World Meteorological Organization (WMO), the World Health Organization (WHO), Unesco, the International Council of Scientific Unions (ICSU) and the International Union for the Conservation of Nature and Natural Resources (IUCN) were also represented. The full list of participants is given in Annex VI.

6. The Council adopted its Rules of Procedure, which are listed in one of the Annexes.

7. The Council discussed the Provisional Agenda, which had the following form:

(1) Opening of the session by the Director-General
(2) Election of Chairman and four Vice-Chairmen
(3) Adoption of Rules of Procedure
(4) Adoption of the Agenda
(5) Report of the Secretariat

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(6) Examination of the priorities for activities under the Man and the Biosphere Programme submitted by Member States and international scientific organizations
(7) Discussion of the general scope and structure for the Man and the Biosphere Programme
(8) Examination of co-operative proposals concerning research projects to be undertaken under the Programme
(9) Examination of co-operative proposals concerning inventories and monitoring to be undertaken under the Programme
(10) Examination of co-operative proposals concerning infrastructure and logistic support for activities under the Programme
(11) Examination of co-operative proposals on exchange of information, education and training connected with the Programme
(12) Constitution of Committees and Working Groups of the Council
(13) Consultation and co-operation with the international governmental and non-governmental organizations interested in the Programme
(14) Date and place of the second session of the Council
(15) Adoption of the report of the session
(16) Closure of the session.

The Council adopted the Agenda on the understanding that the discussions under items 8 to 11 would be organized in the light of the debate on previous items.

8. Mr. Batisse, Director of the Natural Resources Research Division of Unesco, reviewed briefly the origin and history of the Programme and reported to the Council on the Secretariat's activities since the sixteenth session of the General Conference of Unesco, at which the decision to launch the Programme was made. He drew attention to certain misunderstandings that had arisen in some quarters over the respective rôles of, and relationships between, the Man and the Biosphere Programme, the United Nations Conference on the Human Environment, the International Biological Programme and the Special Committee on Problems of the Environment of ICSU. He indicated that it now appeared clear that the rôles of these various activities were complementary rather than competitive. Mr. Batisse reported that in 1971 the Secretariat had been working under abnormal pressure, due to the demands of contributing to a large number of national and international meetings on environmental problems and of assisting in the preparation of the United Nations Conference on the Human Environment. He regretted that this abnormal work load had contributed to the late availability of certain working documents of the Council.

He noted that resolution 2. 313 did not call for the Secretariat to prepare any documents for the first meeting of the Council other than the analysis of replies of Member States on document 16 C/78. Nevetheless, the Secretariat had attempted to prepare a number of working papers which would not prejudice the Council's discussions on the scope and content of the Programme, but which might help to clarify certain methodological and operational problems. Attention was also drawn to the detailed commentaries submitted by relevant non-governmental organizations. Mr. Batisse informed the meeting that some 40 commentaries on document 16 C/78 had been received from Member States. He described the difficulties encountered in analysing the replies of Member States, which varied considerably both in substance and approach. However, he noted that the replies showed a significant degree of convergence on a number of fundamental issues.

9. After a general review of replies and comments from Member States and international organizations, the Council discussed in broad terms the scope, objectives, content, priorities and organization of the Man and the Biosphere Programme.

II. SCOPE AND OBJECTIVES OF THE PROGRAMME

1. GENERAL SCOPE OF THE PROGRAMME

The Council recalled that the Man and the Biosphere Programme is an interdisciplinary programme of research which emphasizes an ecological approach to the study of interrelationships between man and the environment. It will be implemented in close co-operation with the organizations of the United Nations concerned and the competent international non-governmental organizations. It will focus on the general study of the structure and functioning of the biosphere and its ecological divisions, on the systematic observation of, and research on, the changes brought about by man in the biosphere and its resources, on the overall effects of these changes upon the human species itself, and on the education and information to be provided on these matters.

The very nature of the Programme gives it necessarily a wide scope. Generally speaking, it will be concerned with subjects of global or major regional significance rather than problems of local importance that can best be handled at the national level and that do not specifically require international co-operation. Being intergovernmental, it will concentrate on activities where governmental intervention or support is a condition for success.

Interdisciplinary studies on selected environmental problems will form central and essential components of the Programme. Other important problems will be only tangential to the Programme, in part because they are already covered by other international programmes, with which close laison will be arranged. Thus, although the programme is entitled "Man and the Biosphere", it will not be directly concerned with the oceans. In so far as the phenomena which occur there are directly related to terrestrial problems, arrangements will be made with the Intergovernmental Oceanographic Commission (IOC), which is the focal point for development and co-ordination of the Long-Term and Expanded Programme of Ocean Exploration and Research (LEPOR). Similarly, projects dealing principally or exclusively with hydrological or meteorological problems will not be included, since they are already handled within the framework of the International Hydrological Decade and relevant WMO programmes. Here again the necessary links will be established with these scientific programmes whenever required. Problems of a strict management nature, related more specifically to agriculture, industry and health, which are receiving major attention from various intergovernmental agencies, such as FAO, UNIDO and WHO, and which are connected with problems of choice and decision of a non-scientific character, will not be included under the Programme. Similarly, management problems of pollution control and of urban and rural development are not included. The objective of most research themes and projects under the Programme will rather be to obtain the scientific information required to facilitate the solution of these problems.

Though at the present time no definite duration for the Programme has been set, it is thought that the main objectives of a number of projects can be realized satisfactorily within a period of less than ten years. It is considered important, therefore, to make provision for participating countries to undertake periodic and critical evaluation of projects, appraisal of progress achieved and consideration of future action to be taken.

2. OBJECTIVES OF THE PROGRAMME

The Council, having reviewed the objectives set forth in document 16 C/78, decided to formulate the following objectives for the Programme:

The general objective of the Programme is to develop the basis within the natural and social sciences for the rational use and conservation of the resources of the biosphere and for the improvement of the global relationship between man and the environment; to predict the consequences of today's actions on tomorrow's world and thereby to increase man's ability to manage efficiently the natural resources of the biosphere.

With this general objective in mind, the Programme is intended more specifically to develop a limited number of projects:

(1) to identify and assess the changes in the biosphere resulting from man's activities and the effects of these changes on man;
(2) to study and compare the structure, functioning and dynamics of natural, modified and managed ecosystems;

(3) to study and compare the dynamic interrelationships between "natural" ecosystems and socio-economic processes, and especially the impact of changes in human populations, settlement patterns and technology on the future viability of these systems;

(4) to develop ways and means to measure quantitative and qualitative changes in the environment in order to establish scientific criteria to serve as a basis for rational management of natural resources, including the protection of nature, and for establishment of standards of environmental quality;

(5) to help bring about greater global coherence of environmental research, by:

(a) establishing comparable, compatible and, where appropriate, standardized methods for the acquisition and processing of environmental data;

(b) promoting the exchange and transfer of knowledge on environmental problems;

(6) to promote the development and application of simulation and other techniques for prediction, as tools for environmental management;

(7) to promote environmental education in its broadest sense, by:

(a) developing background material, including books and teaching aids, for educational curricula at all levels;

(b) promoting specialist training in appropriate disciplines;

(c) stressing the interdisciplinary nature of environmental problems;

(d) stimulating global awareness of environmental problems through public and other information media;

(e) promoting the idea of man's personal fulfilment in partnership with nature, and his responsibility for nature.

III. CRITERIA FOR SELECTION OF PROJECTS

The Council recommended the following as essential criteria for the selection of projects for the Man and the Biosphere Programme:

(1) That the project would provide information, through research on natural and social sciences (including survey or repeated survey), essential to rational decision-making about the use of natural resources;
(2) That the necessary research is feasible and likely to produce results, in the short- and medium-term, of sufficient precision for the use that is to be made of them;
(3) That significant progress would be enhanced by international co-operation, through co-ordinated planning and execution, the use of compatible or standardized methods, and the availability, interchange and synthesis of information;
(4) That the project lies within the field of competence and responsibility of Unesco, though it may contain some elements that are within the competence of other intergovernmental and non-governmental organizations;
(5) That it should have intrinsic merit as a critical programme of research which will advance knowledge having a bearing on the interrelationships between man and the biosphere.

The Council further recommended as criteria for priorities:

(a) That it should be interdisciplinary, either in terms of scientific disciplines, or in the sense that it includes studies of interactions between human populations and the biosphere;
(b) That it should be of direct assistance and economic significance to developing countries;
(c) That it should be based, where possible on certain selected centres, where appropriate facilities are already available and related research is in progress which could be economically developed;
(d) That it could advantageously be linked with a programme of training, especially of ecologists with some knowledge of the social sciences or vice versa;
(e) That it should lend itself to use for education, demonstration and extension work;
(f) That it should produce significant progress in solving a problem through support provided by the Programme.

IV. SCIENTIFIC APPROACH OF THE PROGRAMME

The Council described the scientific approach of the Programme as follows:

IV. 1 ANALYSIS OF ECOLOGICAL SYSTEMS

A major objective of the MAB Programme is to increase man's ability to manage wisely the natural resources of the planet, in such a way as to maintain their potential. Thus, an essential component of the Programme is considered to be the study of the structure and functioning of the biosphere, and its mode of reaction when exposed to human intervention.

During its evolutionary history, the biosphere has differentiated, as a function of climate, geological substrate, available genetic information and the action of living organisms, into a complex pattern of interdependent units, ecosystems, well-exemplified by the various types of forests, steppes, and tundras which make up the landscapes of the globe. These ecosystems, although part of a larger continuum, are endowed with more or less specific system characteristics and it has been convenient to use them as basic units for research, while recognizing that they can be grouped together in larger units according to their interactions or to research objectives.

The basic design of the ecosystem is that of a machine capable of intercepting radiant energy from the sun, converting it into chemical energy through photosynthesis and distributing this chemical energy in such a manner as to ensure the maintenance of its functional structure. Green plants are instrumental in photosynthesis, herbivores and predators contribute to the distribution of energy and matter, and decomposers permit the breakdown of dead organic materials, thus making the mineral elements locked up in organic matter available again to plants. Control mechanisms, often closely related to species diversity, enable ecosystems to maintain, or re-establish if exposed to disturbance, their functional structure.

It follows that the ecosystem can be studied from the point of view of structure (including spatial arrangement of components and of species composition), functioning (including various processes) and of organization characteristics.

Ecosystems are, in many ways, rather plastic units. Man has taken advantage of this plasticity to modify them for his own benefit by transforming, for example, natural ecosystems into crop ecosystems. There is a limit, however, to the extent to which they can tolerate human intervention. Thus, another essential component of ecosystem research is the study of the reaction pattern of an ecosystem when exposed to external constraints. Such constraints can be imposed experimentally, but considerable information can also be obtained by comparing the structure and function of various ecosystems under similar climatic conditions, or by comparing ecosystems influenced to a different degree by man. Here, the comparison of natural, man-managed and urban systems may prove of particular value.

Ecosystem research may be based on the inventory of micro-organisms, plant and animal taxa, combined when possible with the description of the particular environmental conditions (microclimatic, etc.) to which each taxon is exposed, and the study of relevant components of the ecosystem, soil in particular.

The next step may be to evaluate actual net primary production, followed by studies of certain biogeochemical cycles. It is clear, however, that the degree of sophistication of research will depend on the objective of the research and the manpower and financial resources available, and that only a limited number of projects will be able to study such complex processes as, for example, photosynthesis. It should be pointed out, however, that highly valuable ecosystem research can be carried out even when manpower and financial constraints are severe; studies of primary production and plant-soil-water-air relationships are good examples of this, at least under certain conditions.

It is well recognized that each national research project may emphasize studies of particular importance for the solving of a particular problem. It may be important, in one locality, for example, to identify indicators of biological change, to follow the circulation of pollutants within biogeochemical cycles, to evaluate maximum sustained yield of a given crop, to assess the effects of certain pests and pathogens on ecosystem functioning, to analyse the disruption of natural control mechanisms accompanying the introduction of mono-culture, or to study the reaction pattern of soils to management practices. Comprehensive, sophisticated and basic research of ecosystems should not be neglected, however, as this provides information important to the understanding of how ecosystems, and indeed the biosphere as a whole, function.

As the impact of man's actions on a single ecosystem are often not confined to that ecosystem, then the grouping of ecosystems into more complex units such as biomes and physiographic regions may be desirable. Then an important new research item must be included, that of the exchange of energy and matter between ecosystems.

IV. 2 IMPACT OF MAN ON THE ENVIRONMENT AND OF THE ENVIRONMENT ON MAN

The nature and intensity of man's impacts on a system will depend on such factors as the proximity, concentration and life style of human populations, the pattern of land use, and the type and intensity of management.

Man's impact may be considered to be of two different, though interacting, types. Firstly, there will be that attributable directly to the pressures exerted by human populations, such as the demands of urban conglomerates for easily-reachable recreational space and the consequences of waste disposal and major engineering works. More easily recorded, and more easily controlled and quantified, impacts will include the management practices associated with different forms of land use, such as grazing pressures of large herbivores, application of biocides, irrigation, and the adoption of different cultural practices.

In describing the scientific approach to the Programme, emphasis is given to the assessment of the impacts of man on ecosystem functioning. This will often involve analysis of the performance of, and interaction between, adjacent systems which differ both in functional characteristics and in the type of stresses and management practices induced by man. This analysis will include, wherever possible, the comparison of the functioning of managed ecosystems with natural, undisturbed ecosystems under similar edaphic and climatic conditions. The protection of representative samples of natural systems in the major ecological regions of the world will serve not only as a basis for world-wide networks of national parks, biological reserves and other protected areas. It will facilitate research into the functioning of the undisturbed biosphere and thereby provide a baseline, against which the stability and performance of modified and managed systems can be checked and compared. This will provide a partial means of preserving genetic diversity, but will not in itself be sufficient. Therefore, urgent studies and measures should be taken to ensure the preservation and storage of genetic resources.

Man, in modifying the biosphere of which he is an integral part, will produce new situations which in turn may have a strong bearing on man himself. Man should be considered as being in partnership with nature. This means mutual taking and giving, and thus use and conservation at the same time. This partnership includes all those qualitative values which man needs from nature for his physical and mental well-being. Furthermore, this partnership is the expression of man's respect and responsibility for all other life on earth. In shaping his environment, man is in fact shaping his own future. An important aspect of biosphere research is therefore to study how man perceives his environment and acts upon it in natural, managed and urban systems and how these environments act upon him.

IV. 3 LEVELS OF SPATIAL INTEGRATION

Research within the Programme will be focused on a number of structural units, the size and nature of which depend on geographical region, the problem being studied and the resources available to the project. Thus, for example, an analysis of the grazing behaviour of wild herbivores will generally involve an area of research much larger than that required for a comparison of the photo-synthetic performance of adjacent fields of wheat and clover. It can be envisaged that some national projects will focus attention on the impact of one type of stress on a single system of small area. Other projects will deal with a mosaic of systems, each with its own structural and management characteristics. Still other projects will take a broad physiographic or socio-cultural region, such as a river basin or island, as the area of study. These areas can be thought of as integrating units, providing a microcosm for study of the complex interactions and feed-back relations between man and the environment which are detailed in the various international research projects.

Integrating units such as a river basin illustrate well the interactions and interrelations that occur between ecosystems. For example, the water which falls on high mountains and high forests drains to the lowland forest, grazing lands, agricultural systems on alluvial soils, and eventually to the lakes and rivers. Human activity modifies the interrelations between these systems, and this is reflected in changing patterns of productivity and of transport of dissolved and suspended particulate matter. The integrated effects of these changes are felt in estuaries, deltas and adjacent coastal waters. Thus, in studies on broad physiographic regions such as river basins, the main drive will be to identify problem areas in human management of these systems and to make proposals which will ensure that deterioration under the growth of human populations is kept to a minimum, and that productivity, genetic diversity and the quality of the environment are maintained and enhanced.

IV. 4 FORECASTING FOR ACTION

In general, the Programme will comprise problem-solving projects of a short and medium-term nature. Each international project will, as far as possible, develop procedures for the forecasting necessary for rational and responsible management, both on a temporal and spatial basis. This will involve the application of simulation techniques, the testing of macromodels for different biological systems (as well as the several micromodels or sub-models that can be identified within each macromodel), and the transfer and use of findings from projects in developed countries to those in developing regions of the world.

The use of modelling techniques is based on the fact that, if the state of an ecosystem or a complex of ecosystems at a given time can be expressed in mathematical terms, there is greater opportunity to give quantitative expression to the effect of perturbations on the structure, functioning and management of ecosystems. Processing of data in this form also increases their informative value and helps to widen the application of results from one situation to another.

In Annex II, more detailed information, adapted from working documents of the Council, is given on certain aspects of the study of the structure, functioning and dynamics of ecosystems. Information is also provided on certain methodological problems such as ecosystem modelling and remote sensing.

V. SCIENTIFIC CONTENT OF THE PROGRAMME

The Council, having reviewed the research themes detailed in document 16 C/78, and having considered the views of Member States on the scientific content of the Programme, defined the international scientific projects of the Programme.

The Council felt that different countries, in considering the list of international research projects, might wish to deal with the projects in different ways. A particular country may wish to group a number of projects, it may wish to select and combine appropriate actions given under "the possible fields of action" of several projects, it may deem it necessary to adapt any international project to its own needs. Each of these procedures is acceptable to the Council; indeed it is considered desirable in a co-operative programme of research between Member States.

It should also be noted that the list of international research projects is in no way a final or definitive list. The Programme, while firmly centred on the interactions between man and the biosphere, will retain a flexibility both in content and approach. It is foreseen that, as some activities become complete, others will change in direction, and new projects will be added as and when the need arises.

The proposed international scientific projects are described in the following pages. It should be stressed that neither the order in which the projects are presented, nor the length or detail of the commentary given for each project, denotes any priority judgement by the Council. It should also be stressed that the planning and implementation of all projects will be carried out in close co-operation with the relevant intergovernmental and non-governmental organizations concerned, whether or not they are specifically mentioned in the description of the projects.

PROJECT 1

ECOLOGICAL EFFECTS OF INCREASING HUMAN ACTIVITIES ON TROPICAL AND SUBTROPICAL FOREST ECOSYSTEMS

The problem

Tropical forests, both the high forests of hot, humid regions that lack a pronounced dry season, and those forests occurring in seasonally dry climates, form intercontinental ecological regions or biomes of considerable extent and importance. They are characterized by great biological richness and diversity, large standing crops and rapid mineral circulation. They include a wide range of ecosystems which in general have not received the attention given to forests in temperate regions, and therefore hold promise for the emergence of new principles and concepts.

Despite their large biomass, most tropical forest biomes have not supported many people at better than subsistence level. In recent decades, however, increasing population pressure in certain parts of the tropical and subtropical world has forced serious misuse of the lands in these regions, and a much more thorough knowledge of their ecology and of human attitudes is essential if these biomes are to remain productive. There has been a change from the traditional forms of shifting cultivation to various types of cultivation, replacing tropical and subtropical forest ecosystems. Under these conditions, some soils lose their structure and fertility. After a few years of continuous cultivation by plough, the soil surface becomes compact and yields are reduced, despite the use of inorganic fertilizers; finally the site is abandoned. Within the past decade or so, this problem has become widespread throughout tropical and subtropical regions. There is a need to co-ordinate the existing research in this field and to launch a much more detailed research programme. One of the major aims of the project is to determine the ecological bases of choice of rotations or agricultural practices in view of maintaining soil structure and fertility, so that the soil can be utilized under some system of permanent agriculture.

In other parts of the tropical and subtropical world, another type of problem presents itself. Here, certain forests are subject to widespread destruction through human penetration and/or deforestation, thus disrupting the existing plant-soil-water and plant-animal relationships. There is need for conservation and study of representative areas of these forests, in view of determining how to minimize the adverse consequences that may sometimes result from these actions.

Studies within this project will concentrate on the composition, structure and functioning of tropical forest ecosystems, with special attention to the trophic-dynamics of production processes and changes in productivity, soil structure and fertility, water balance and hydrological cycle, biogeochemical cycles, biotic interrelations, microclimate and pedoclimate. These studies should encompass not only natural stands of tropical forest but also those modified by silviculture, cultivation, pasturage and plantations.

Special attention is called to the fact that certain successful kinds of cultivation in tropical forests, as in the case of cocoa and rubber, simulate the natural ecosystems and do little more than increase the abundance of one or more species in the "natural" plant cover, whereas, in contrast, many efforts at complete forest clearing followed by monoculture have had difficulty or have failed.

Possible fields of action (in co-operation with the international organizations concerned)

(1) Assessment of the consequences of selective cutting of forest species.
(2) Studies of the use of small clearings in the forest for patch or strip cultivation, as in traditional and modern shifting agriculture.
(3) Analysis of the consequences of extensive clearing of tropical forest areas for agriculture, pasturage and plantations. Degenerated as well as cleared forests often lead to the formation of grasslands which, although tending to be unstable, are often useful to man. The dynamics of their maintenance and management need to be studied. Also studies of deep-rooted leguminous and grass fallow crops, probably as part of a crop rotation, should be initiated or strengthened.
(4) Investigations of tropical and subtropical forests with alternating wet and dry periods which expose the soil to erosion and depletion of organic matter.
(5) Studies of the mineral nutrient flow carried by water from upland forests to the lowland cleared areas, and analysis of ecosystem changes in both the upland forests and the lowland areas.

PROJECT 2

ECOLOGICAL EFFECTS OF DIFFERENT LAND USES AND MANAGEMENT PRACTICES ON TEMPERATE AND MEDITERRANEAN FOREST LANDSCAPES

The problem

The temperate forest biomes include a wide range of forest ecosystems from high latitude and mountain coniferous forests through to deciduous broad-leaved forests and the mixed deciduous and evergreen forests of warmer, more humid regions.

Larger areas of these forests have long since been cleared and replaced by agricultural or urban forms of land use. Other areas have been extensively planted with rapidly growing trees for use as timber, pulp or fuel. Still others are managed as natural forests under varying degrees of intensive forestry. All these forests have important economic, ecological and social functions for the human populations living within these regions.

The Mediterranean woodland biomes support several types of vegetation ranging from dense evergreen woodlands, shrublands and steppe through to "man-made" deserts. Fire, when misused, has been destructive to these biomes, but with proper use can be a valuable management tool. In the area around the Mediterranean Sea, these biomes have been both long settled and most severely degraded by past land use.

Present-day, forest landscapes in temperate zones have been greatly shaped and modified by man. Modern forestry has introduced new methods of utilization, such as the mechanization of harvesting (cutting systems, forest roads) and the development of methods for obtaining increased yield (drainage, fertilizers, biocides, cutting related to regeneration, planting, sowing, introduction of new provenances and species, the results of breeding). External factors, such as regulation of water catchment areas and air pollution emanating from nearby or distant sources, have a profound effect not only on the functional characteristics of these ecosystems, but also on their capacity for use for recreational and wildlife purposes.

It is evident that the utilization of forests depends on biological as well as on socio-economical criteria. Consequently, research is needed to form the basis for a proper evaluation of the optimal utilization of forests for various, but not mutually exclusive, goals (of ecological, economical and social kinds).

In many countries, three main problems that arise are those of forest management and introduction of timber trees, fire, and tourism and recreation. Many of these problems have been given considerable attention in the research carried out by forest research institutions and other organizations dealing with related problems, including intergovernmental and non-governmental organizations. However, there is still great lack of information on the structure and functioning of these forest ecosystems as total entities and on the social aspects of man's impacts and interactions with forest landscapes.

It is therefore necessary to continue, strengthen or establish a number of integrated projects for analysis of the functioning of representative forest ecosystems, including evaluation of their interrelations with other landscape units. These projects will be organized at the national level, but will benefit from international co-operation and co-ordination. Each integrated project must have a certain minimum size and should be planned from a s stems approach standpoint. It is, however, desirable to supplement the large projects, which necessarily have to be limited in number, with a series of supplementary projects intended to solve special problems, as well as supplying additional information for comparison and synthesis.

Possible fields of action (in co-operation with the international organizations concerned)

Analysis of ecosystem functioning under the various degrees and types of stress imposed by different management practices and social impacts should be undertaken.

Among the specific topics to be studied, in this project, might be:

(1) Evaluation of the effects of the introduction of fast growing, exotic species and the use of different management practices on forest ecosystems.
(2) Assessment of the water balance of forests, and the rôle of forests in maintaining water resources and in regulating water flow in river basins.
(3) Analysis of the impact of air pollution on the composition and performance of forest ecosystems.
(4) Evaluation of the consequences of tourist and leisure activities.
(5) Studies of the effects of fire on forest ecosystems.

PROJECT 3

IMPACT OF HUMAN ACTIVITIES AND LAND USE PRACTICES ON GRAZING LANDS: SAVANNA, GRASSLAND (FROM TEMPERATE TO ARID AREAS), TUNDRA

The problem

Tropical grasslands and savannas include a wide range of ecosystems which cover substantial areas of the tropical world. They form a large area for potential use by man for the growing of crops, the grazing of animals, the production of wood fuel and building materials, and for recreation and tourism. The development of these biomes, however, poses a number of urgent and often apparently intractable problems. These include the dangers of soil deterioration and erosion, overgrazing, the devastating effects of the misuse of fire, and the encounter by man with a variety of diseases. The value of the native biota of these biomes has been inadequately understood and commonly neglected.

In the extensive grazing lands of arid zones, the degradation of natural vegetation and soil is primarily due to human interference. Many of these lands have been degraded and destroyed within living memory. The process of destruction is, in many instances, not yet completed. Here is the scope of immediate and urgent action.

The temperate grassland ecosystems form a continuum from tall grass prairie of the humid, temperate region to the short grass steppes of more arid regions and to the grazing lands of the arid zones. Except for very local and sometimes ancient cultivation, large areas of these biomes in the old world have been used for grazing over thousands of years. Extensive use for cereal agriculture is scarcely more than a century old, having awaited the invention of an effective, sod-breaking plough. The virtual extinction of these grasslands as natural vegetation over vast areas by overgrazing, by cereal agriculture and the development of hay fields and mixed farming, raises many questions of an ecological nature for which scientific and biological answers do not now exist.

The tundras are treeless areas which support low-lying vegetation of shrubs, herbs, mosses and lichens. Vegetation is influenced by the presence and variation of permafrost. The relation of primary to secondary production is subject to periodic reversals, often associated with migrating animals which may be present in great numbers. Tundras have been occupied relatively little by man and, if so, by sparse populations. Some of them, however, support transhumance grazing, the seasonal moving of livestock from one area to another. Recently the influence of modern technology is being felt as the development of oil fields and other natural resources begins to take place. These areas are extremely vulnerable to all forms of disturbance.

The overall objective of the project is to further grazing land research and development by providing an integrated programme consisting of a scientific framework for utilizing existing information, improving research and carrying out training; taking into account the progress made already by, and current activities of, other governmental and non-governmental organizations. These studies must take into consideration ecosystem interfaces.

Possible fields of action

The major tasks to be accomplished will include the following:

In savannas and related tropical grasslands:

(1) Studies of the effects of land management and grazing on ecosystem transformation, including changes in bioclimatic conditions.
(2) Comparative studies of domestic and wild animals (as individual species and as natural groups within ecosystems) with a view to finding the most efficient producers of proteins; where appropriate as tourist attractions and natural gene pools; and as influence in the maintenance of ecosystem integrity and stability.
(3) Studies of the effect of fires in different areas, including the co-ordination and more scientific pursuit of many existing experiments on different intensities and times of burning.

In arid zone grasslands:

(1) Studies of the results of the establishment of pastures and herbaceous plants for grazing, shrubs for browsing, and mixtures of grass, forbs and shrubs for general purposes.
(2) Studies of the effects of the use of inorganic fertilizers on ecosystems as a whole, and especially because their effects on the soil biota are practically unknown in this kind of ecosystem.
(3) Evaluation, in different land-use areas, of the phenomena of water spreading and runoff use, in relation to landscape features and possible engineering works and taking into account land-use practices employed in ancient times.
(4) Studies on the problem of wind erosion which, in addition to overgrazing, is a major factor in the desertification of arid lands and adjacent areas.

In temperate grasslands:

(1) Analysis of the changes in ecosystem components and processes attendant on different intensities of grazing pressure and management practices, including development of the computer-simulation approach to plant-herbivore relationships.
(2) Comparative studies of monoculture and rotating practices.
(3) Analysis of the changes occurring in the storehouse of fertility, and the effects of these changes on soil structure and water balance.
(4) Evaluation of the long-term consequences of changes of nitrogen content through ploughing and cultivation of grasslands.
(5) Assessment of the consequences of cropping for soil microflora and fauna.
(6) Studies of the effects of management on the transfer of diseases between man and animals.

In tundras:

(1) Assessment of changes in vegetation cover, animal populations, drainage conditions and level of permafrost, due to such human activities as industry and the building of transportation systems, stress being laid on problems related to the slow regeneration rate of tundra ecosystems.
(2) Study of the instability of tundra ecosystems in relation to climate and species diversity.

PROJECT 4

IMPACT OF HUMAN ACTIVITIES ON THE DYNAMICS OF ARID AND SEMI-ARID ZONES' ECOSYSTEMS, WITH PARTICULAR ATTENTION TO THE EFFECTS OF IRRIGATION

The problem

The desert and semi-desert biomes include an array of ecosystems that vary from cold to hot deserts, and include "man-made" deserts resulting from overgrazing, cutting and the misuse of fire in areas with higher rainfall.

Principal attention needs to be given to the various semi-desert and desert shrub ecosystems that historically have been, and now can be made, more productive. It has been shown that the present very low carrying capacity can be increased enormously if grazing is carefully controlled through improvement of plant cover and water management.

The spread of deserts due to man's actions is of particular concern and need not continue. Better knowledge of the ecological relationships that exist within these biomes, and a better understanding of human attitudes and activities in these environments will help to prevent further degradation and to restore the productive capacity of these lands.

Particular attention should be paid to arid zone soils which can only be exploited on a wide scale by irrigation. Through irrigation, productivity can be increased several-fold. Before the end of this century the world area of irrigated lands may reach 300-350 million hectares. Irrigation will penetrate more and more into semi-arid and even semi-humid zones, creating the opportunity of obtaining high yields of such crops as wheat, rice, corn. Since the use of underground water is one of the ways to obtain water for irrigation, studies should be made of the availability of this resource.

Unfortunately, irrigation, if wrongly designed and poorly managed, is very often followed by degradation of soils. In addition, many other problems, such as spread of human disease, may arise. The phenomena of waterlogging, salinization, alkalinization, cementation of soils and erosion of slopes, have in many countries completely destroyed, or reduced, the fertility of millions of hectares of previously productive land.

Lack of knowledge on how to obtain the highest yields of plants maintaining an optimal water-salt regime in irrigated land is the main reason for the degradation of irrigated lands. There is also a lack of knowledge on how to protect the land by such practices as reforestation. Fundamental research into the problem of the continued productivity of irrigated lands is required. Long-term experience of existing irrigation procedures and schemes must be compiled, studied and synthesized.

Irrigated ecosystems should therefore be looked at in an interdisciplinary way, with bio-social as well as ecological aspects being considered. This might include the study of the processes of settlement of nomadic populations.

Possible fields of action (in co-operation with the international organizations and programmes concerned, such as FAO, WHO, WMO and IHD)

(1) Case studies of representative irrigated ecosystems suffering from soil degradation.
(2) Observation of the seasonal dynamics and evolution of air-plant-soil-water relationships under irrigation, and evaluation of the changes in ecosystem components and processes (such as water dynamics, soil organic matter, structure and fertility levels of soils) resulting from irrigation.
(3) Studies of the water use of the cultivated irrigated plants, to determine the most efficient use of water and to help prevent salinization and other changes in soil structure which may be irreversible.
(4) Studies of the impact of man-made modifications on the microclimates of various arid and semi-arid ecosystems.
(5) Studies of the migratory and nomadic movements of human and animal populations in response to alternating periods of extreme drought and humidity.

PROJECT 5

ECOLOGICAL EFFECTS OF HUMAN ACTIVITIES ON THE VALUE AND RESOURCES OF LAKES, MARSHES, RIVERS, DELTAS, ESTUARIES AND COASTAL ZONES

The problem

Lakes, rivers, deltas, estuaries, lagoons and the coastal zone (including intertidal marshes and the seaweed zone) are naturally productive areas which supply a significant proportion of the world's food protein and are also important areas for amenity, recreation and wildlife conservation. Human settlements tend to be concentrated on major lakes, rivers, estuaries, deltas and coastlines, and human activity is threatening the productivity of these zones.

Lake and river impoundments are changing the seasonal flow patterns of rivers, and use of water for irrigation is greatly reducing their total flow. The result is a reduction in the supply of silt and nutrients which are responsible for the great productivity of the deltas, and impairment of the estuarine mechanisms which control aquatic production. Salt marshes are being filled or modified, with a loss of their productive capacity which is important for the productivity of the whole coastal zone.

Change in flow patterns of major rivers can also alter the environment of the estuarine area, and produce unforeseen effects on the human population. The flow of nitrates and phosphates into lakes and rivers from fertilized soils and from animal and human wastes is causing eutrophication, with consequent loss of amenity value and a shift to less desirable species of fish. Pollution by toxic substances is also a major problem. A combination of the factors listed above is reducing the stocks of salmonid and other fishes which migrate up rivers to breed. Deltas have a high natural instability, as well as a high productivity, and technical developments in deltas have almost always led to deterioration of the ecosystem.

It is proposed that studies be conducted in co-operation with the international organizations and programmes concerned such as FAO, WHO, WMO, IHD, LEPOR and IUCN, on a number of lakes, marshes, rivers, deltas, estuarine and coastal systems of the world, to identify the mechanisms underlying the effects listed above, and to develop methods of avoiding or ameliorating them.

Possible fields of action

(1) Studies on the relations between human activities, river flow patterns, sedimentation and estuarine mechanisms to establish the effects of human activity on the seasonal pattern of physical and chemical events in estuaries and deltas.
(2) Studies of the relation between these physical and chemical events and biological production mechanisms in deltas, estuaries and adjacent coastal waters.
(3) Studies of the special problems of coastal settlements, in areas where estuarine flushing methods are lacking, to establish effective methods of waste disposal which preserve the quality of the coastal environment.
(4) Analysis of the effects on human populations, through changes in such factors as bioclimate, productivity, or recreational and cultural value of lakes, marshes, rivers, deltas, estuaries and coastal zones.

PROJECT 6

IMPACT OF HUMAN ACTIVITIES ON MOUNTAIN ECOSYSTEMS

The problem

Mountainous landscapes are of paramount importance for the biosphere and for humanity. Much of the fresh water of rivers and of artesian basins originates in mountain regions. Geochemical and mechanical transportation of many substances starts in mountain areas. Substances are transported to lowlands and eventually enter the oceans. The climate, sunlight, quality of air and minimal pollution all contribute to the importance of mountain areas for the recreation and well-being of man.

In many ways, mountains represent "islands on land", and have a number of characteristics in common with oceanic islands. Isolated as they are from one another, they have a high degree of endemism, relict species and communities. Some of them have also human populations adapted to these environments and completely dependent on their production. They are further extremely vulnerable to disturbance by man's activities.

From the point of view of land use, the mountain forests are important for the proper maintenance of water supply and climatic conditions on the plains below. There is an increasing interest in the multiple use of mountain areas for hunting, fishing, recreation, tourism, water regulation, hay production and grazing. All these may lead to the increased development of technical installations and transportation routes.

Deforestation, misguided forest management methods, unwise ploughing, overgrazing, poorly designed road construction and mining, are often followed by erosion of soils and the exposure of rocks and formation of stony deserts. Catastrophic floodings, mass movements of land, exhaustion of the rivers and springs and disappearance of fauna and flora are typical results of poor management of the meadow, forest and aquatic ecosystems in mountains. The adverse consequences of all these phenomena are felt as far as into the valleys, the plains and the deltas.

The threat of unwise human activities in these ecosystems and the irreversible nature of the deterioration which would ensue, present challenges requiring urgent attention. There is a need, therefore, to study the stability - or lack of stability - of vegetation and soils in relation to the requirements for successful adaptation to, and use of, such areas.

Possible fields of action (in co-operation with the international organizations concerned)

(1) Evaluation of the inputs and outputs of mountain areas with particular reference to problems of erosion and instability.
(2) Investigation of the mechanisms involved in the evolution of species and ecotypes, the survival of relict forms and the introduction or reintroduction of species in these regions.
(3) Promotion of studies of the responses of high mountain ecosystems to man-made disturbances, with attention to long-established land use practices and to the impact of activities associated with recreation, tourism, water and other resource development, including the hydroelectric projects, and summer pasturage.

PROJECT 7

ECOLOGY AND RATIONAL USE OF ISLAND ECOSYSTEMS

The problem

Because of their isolation and limited size, and the restrictions imposed by substrate, islands often develop unique and highly fragile biotic communities that lack many of the components found in continuous continental areas. They often support a wide range of endemics that have evolved locally or have survived only because of the isolation - and inherent protection against invaders - that these physiographic units provide.

Moreover, many islands were settled long ago, and their human populations have often developed unique characteristics in response to their isolation and to their physical environment.

Islands, especially small and remote islands, are particularly vulnerable to human interference, including man's deliberate or accidental introduction of animals and plants. As a result, the natural biotic communities which are characteristic of a very long evolution, hitherto relatively well protected against outside interferences, are readily disrupted or destroyed. If man is to use and manage island environments, without destroying the native fauna and flora, it is essential that the ecology of these islands be better understood.

For many islands, tourism is the principal mainstay of the economy. Studies leading to the wise management of these physiographic units have therefore a particularly great socio-economic importance.

Islands have been described as ideal laboratories for the study of demography, evolution and population genetics, immunology, and interactions between species. In few other places on earth does the necessity for achieving a balance between populations and environments become more quickly apparent, and in few other places is it easier to study direct interactions between populations and environment.

Possible fields of action (in co-operation with the international organizations and programmes concerned, such as FAO, WHO, WMO, IUCN and LEPOR)

(1) Analysis of the structure, dynamics and stability of ecosystems on selected islands representing the range of variation of island types, from tropical to polar islands, from near-shore to distant oceanic islands, coral formations, detritus islands, volcanic islands, etc.
(2) Investigations of the factors leading to success or failure in species colonization and establishment on selected islands, including interaction between species and the establishment of biotic communities.
(3) Analysis of factors leading to stability or instability in island biotic communities, with particular reference to the disturbing effects of human activities and to resistance to invasion by new species, but also with reference to hurricanes, volcanism and other natural processes.
(4) Study of factors leading to the evolution of races and species in island environments and analysis of factors favouring survival of relict species and communities of plants and animals.
(5) Study of social, economic and biological parameters among human populations on selected islands, to elucidate ways in which isolated and tradition-oriented cultures can adjust to the impact of modern technological society.
(6) Feasibility for long-range planning for rational use of island environments and the means for maintaining environmental quality under varying levels of human population density, in order to provide a high degree of economic benefits for island peoples while maintaining suitable environmental conditions.
(7) Investigation of the relations between demography and environment on selected islands, including studies of immigration and emigration.

PROJECT 8

CONSERVATION OF NATURAL AREAS AND OF THE GENETIC MATERIAL THEY CONTAIN

A. Co-ordinated world-wide network of protected areas

The problem

It is recognized that the establishment of reserves, protected and managed in various ways, is of importance to mankind through the rôle they can play in meeting scientific, economic, educational, cultural and recreational needs. Such areas are irreplaceable for studies of ecosystems of various kinds and of fundamental importance to the Programme. They represent baselines or standards against which change can be measured and the performance of other ecosystems judged. They represent a means for maintaining the gene pools of species of plants, animals and micro-organisms in all of their diversity. Unfortunately, the present system of reserves and protected, managed areas is inadequate in its representation of species and ecosystems on which many research projects will be concentrated.

Action to establish an adequate network has so far met with disappointing results in many countries. Efforts to take full advantage of the multiple values such areas can offer to any nation have been insufficient. It is proposed, therefore, in co-operation with the intergovernmental and non-governmental organizations concerned, to assist governments to select, to set aside and to manage the areas needed to provide the required international network.

Possible fields of action

(1) Evaluation of existing information on reserves and protected areas to determine the degree to which they satisfy existing and foreseeable needs for a world network of protected areas.
(2) Location of ecosystems little affected by man, of centres of diversity, and of areas where the wild progenitors of domestic species and existing, but endangered, domesticated species and varieties, are still to be found; provision of adequate protection and management for these areas.
(3) Assistance to Member States in establishing an adequate network of protected areas.
(4) Promotion of acceptable standards for management of these protected areas and assistance to Member States in achieving these.
(5) Assistance in organizing scientific and educational activities related to these sites.
(6) Establishment of a recognized and acceptable degree of international concern for the long-term conservation of these areas, through their designation as biosphere reserves and the promotion of standards for their conservation.

B. Conservation of animals and plants, including micro-organisms

The problem

Considerable and growing concern has been expressed that many species and varieties of potential or current use to man are disappearing as a consequence of his activities. It is important that the widest possible diversity of such species be maintained:

(i) for the ecological health and functioning of the biosphere;
(ii) for direct use as natural resources;
(iii) for their educational, scientific and cultural values; and
(iv) for their potential future contribution to man's survival and well-being.

Lost species and genetic diversity cannot be replaced or reconstituted. It is important therefore that special measures be taken to preserve these species. For some, a system of reserves or specially managed areas may be adequate. For many others, other measures will be required, including storage and registry systems for plant seeds and propagules and/or the maintenance of carefully managed breeding populations for protecting the genetic diversities concerned, and the enactment and enforcement by nations of appropriate conservation measures. The actions given below will be undertaken in co-operation with the competent intergovernmental and non-governmental organizations, such as FAO, IUCN and ICSU.

Possible fields of action

(1) Expansion, co-ordination and improvement of methods in existing gene banks and data storage and retrieval systems, so as to include the widest range of cultivated species and populations and their wild relatives and progenitors.
(2) Establishment of special measures of protection and management to guarantee the perpetuation in the field of wild and domestic species and varieties.
(3) Assistance to short-term emergency measures to safeguard endangered species and varieties, or to rescue and maintain those severely threatened by human activities.
(4) Extension and improvement of the existing inventories and assessments of the status of species.
(5) Assessment of the population dynamics, habitat requirements and sustainable yields for all species being exploited commercially, with particular attention to the minimum areas required for optimum conservation of the widest spectrum of species and varieties and for ensuring high species diversity.
(6) Provision of information and assistance needed to control exploitation rates through national and international measures and agreements.
(7) Establishment of guidelines for management of species and their habitats.

PROJECT 9

ECOLOGICAL ASSESSMENT OF PEST MANAGEMENT AND FERTILIZER USE ON TERRESTRIAL AND AQUATIC ECOSYSTEMS

The problem

Although this problem has been considered in other projects, in connexion with the equally significant effects of industrialization and urbanization, it has an influence on so many ecosystems that it should be detailed as a separate project.

Crop pests are artificially controlled in intensive agriculture and forestry through two principal kinds of activities: namely, crop breeding for pest resistance and application of chemical pesticides. This system has been eminently successful in producing consistently high yields of food and fibre for more than 30 years in many parts of the world. There is reason to believe, however, that major difficulties are likely in the next few decades - difficulties that are likely to be surmounted only through a major international effort to develop alternative strategies for management of pest populations.

Two particular categories of problems are of world-wide concern. The first concerns the broad environmental consequences of widespread use of chemical pesticides; the second, the declining effectiveness of chemical control in many areas. In solving problems of the first type, and in developing new approaches, sound ecological research on new methods is essential. This internationally co-ordinated ecological project is a necessary complement to the specialized agronomic approaches to pest control actively being pursued by individual nations and FAO.

Fertilizers which are excessively or inappropriately applied may have widely dispersed adverse effects on aquatic ecosystems and ground water resources. Additional research is necessary to assess the magnitude of this problem and to elucidate the mechanisms of transport within and between ecosystems.

Cultivation to control weeds and fire to control brush, weeds and plant diseases may result in increased soil erosion. Rotations of crops to control weeds, plant diseases, nematodes and insect pests may result in increased cultivated surfaces, increase in erosion risk with resulting salt concentration in aquatic systems, and reduction in the areas available for forest and other non-cultivated use.

Herbicides are only partially selective; non-target species, both within and near the area of application, may be adversely affected. Some herbicides can persist from one year to the next in the soil. Crop and other species grown in the crop year following the application of such herbicides may be adversely affected.

The ecological research to be undertaken, in close co-operation with the competent international organizations, such as FAO, WHO and WMO, will be directed toward obtaining information which will be of value to all countries in pest management and enhancement of productivity with a minimum of adverse effects on non-target species and on the environment.

In many cases, collection of baseline information will be necessary in order to analyse the current status of terrestrial and aquatic ecosystems, or of populations of selected indicator species, before assessment of the impact of pest management and the increasing use of fertilizers can be made.

Possible fields of action

(1) Collection of baseline information in selected agricultural, forest and aquatic research sites within landscapes of known patterns of pest management and fertilizer use. Such baseline information will include data on: soil characteristics; weather and climate; plant, animal and microbiological species, including indigenous, introduced, cultivated, managed and unmanaged taxa.
(2) Collection and analysis of statistically adequate samples of soil, water, air and biota, with particular emphasis on analysis for residues of pesticides, chemicals and plant nutrients. Such analyses should be made on samples collected at stated intervals before and after application of pesticide chemicals or fertilizers.
(3) Promotion of population studies of target and non-target species in the research sites and in the agricultural, forest and aquatic ecosystems in the landscapes within which the research sites are located. Such studies should be maintained over at least three years following the establishment of baseline values. Population studies are especially needed on "sentinel" and "indicator" species - those species in which changes in biological and population characteristics may have forecasting and predictive value with respect to impending changes in productivity, diversity and stability of ecosystems and indeed landscapes as a whole.
(4) Promotion of population studies based on the integration of ecological approaches to pest control by chemical and agronomic methods. Included here are studies of the population dynamics of species associated with pests, and the rôle of spatial and temporal heterogeneity in ecosystem stability.
(5) Evaluation in co-operation with organizations responsible for information dissemination, advice, policy and action with respect to pest management and fertilization, of the risks, costs and benefits - social, esthetic and economic - of different pest management and fertilization practices, including assessment of realized increases in productivity and any adverse effects on non-target species and on the environment.
(6) Formulation and dissemination of information on the effects, both beneficial and adverse, of the alternate methods of pest management and fertilization studied.
(7) Development and testing of predictions of the environmental impact of alternate methods of pest management and the fertilization of agricultural, forest and aquatic ecosystems through systems analysis, simulation studies, model refinement and technology assessment.
(8) Dissemination of information on the environmental impact of alternate methods of pest management and of fertilization of agricultural, forest and aquatic ecosystems, in order that such ecosystems may be managed for enhanced and sustained productivity and environmental quality.

PROJECT 10

EFFECTS ON MAN AND HIS ENVIRONMENT OF MAJOR ENGINEERING WORKS

The problem

Man, in modifying his environment, should use technology to simultaneously achieve enhanced economic development without impairing environmental quality. Since the development of new technologies has made possible engineering works (such as dams, highways and transport systems) on a scale not previously attainable, a fuller knowledge of the total consequences of such works is required.

Some of the contemplated or planned works are on such a massive scale that they will require a major programme of research to estimate these consequences. There are, however, a number of more modest works on which there is already available a considerable body of expertise and information.

The objective of this category of projects is to encourage systematic and comparative studies of the complex ecological consequences of such works and to provide guidelines to governments and international agencies on how this type of engineering work could be carried out with fewer adverse environmental consequences.

Through this study project, the MAB Programme will seek to collect and elaborate information which will assist Member States and international organizations, at their request, in the development and application of ecological assessment in planning major engineering schemes.

Member governments and other international organizations concerned are invited to stimulate and, where they have specific programmes already, to participate in an integrated programme of research on this problem.

Possible fields of action

(1) Case studies of the consequences of such engineering works. These studies should:
   (a) assess before the scheme is started: the distribution, numbers, health and socio-economic structure of the human population within the area most likely to be affected by the works; the broad characteristics and structure of the environment within the area, such as the composition of flora and fauna and soil characteristics;
   (b) assess during the construction of the works the adaptation of the human population and the modification of its environment;
   (c) assess at intervals after completion the total human and environmental consequences of the works.
(2) Collation and analysis of information on the basis of these case studies, and elaboration of ecological principles from this analysis which could be useful for:
   (a) governments and agencies who might wish to carry out and analyse the results of future surveys and research;
   (b) governments and in particular international agencies which are planning and executing such engineering works, in order that they might be aware of the undesirable consequences of them.

PROJECT 11

ECOLOGICAL ASPECTS OF ENERGY UTILIZATION IN URBAN AND INDUSTRIAL SYSTEMS

The problem

The extremely rapid growth of cities and the development of industrialization, in both developing and developed countries, is associated with problems of ecosystem modification and of human adjustment to changing environments. These problems range from those of environmental imbalance to those of nutrition and public health, to those concerned with the broadest aspects of national and regional economy and society.

In order to obtain a proper understanding of these problems, it appears, on the face of it, that it is necessary to approach the study of these systems from multiple points of view, in terms of their influence on other parts of the biosphere and by using the community knowledge of both the social and natural sciences.

These systems are in a state of continuing disequilibrium, and their transformation from one sort of complex system to another requires investigation of factors relating to their disequilibrium state. Urban environments are aggregates of human beings intensively using primary and secondary products produced elsewhere, accumulating wastes which are disposed of rather than recycled and thus radically changing the natural order of nutrient distribution and availability.

An holistic comparison of the dynamics of urban and industrial ecosystems can best be approached by focusing attention on certain particular characteristics of urbanization and industrialization.

A useful entry into the problem follows from the recognition that the interactions between man and the rest of the biosphere increase with the product of the number of men and the energy expenditure per man. Experience has shown that these interactions are, all too often, deleterious. Thus it would seem appropriate to promote studies on the per-capita needs of different human societies and settlements, directed particularly toward the research and development of technologies which will permit human life patterns of high quality but with more rational use of energy.

Member States, with the assistance of competent international organizations, are invited to participate in an interdisciplinary programme of studies on the functioning of urban and industrial systems, with emphasis placed on the unifying and fundamental rôle of energy in man-environment interactions in these systems.

Possible fields of action

(1) Evaluation of the extent and spread of urban systems and other man-made surfaces in the biosphere.
(2) Investigation of the influence of urban infrastructures on ecosystem dynamics.
(3) Studies on the energetics of urban and industrial systems such as:
   (a) the energetics of human transport and communications, including the effects of spatial patterns on the energetics of transport;
   (b) the energetics of human habitations;
   (c) the energetics of industrial engineering and construction works.
(4) Specific waste recycling projects with emphasis on energetic aspects, including such aspects as assessment of the rates of accumulation and rates of breakdown of human wastes and synthetic compounds in soils and waters, and the capacity of organisms to reduce and decompose these substances in different climatic and ecological regions.
(5) Evaluation of the impacts of urbanization on agriculture, forestry and rural life in the hinterlands of cities, taking particular account of the zones of interaction between urban and rural systems.

PROJECT 12

INTERACTIONS BETWEEN ENVIRONMENTAL TRANSFORMATIONS AND GENETIC AND DEMOGRAPHIC CHANGES

The problem

The impact of recent and current population transformations through rapidly increasing populations, changes in genetic and demographic structures, differences in human adaptability, occupational shifts, and migration, are recognized to have marked effects on man's environment and to modify man-environment relations in general.

Two research and development strategies seem to be suggested by this postulate. First, one concerned with demographic variables themselves. Then, a second concerned with relations among population densities, population distributions, resources, and settlement patterns in different cultural situations. The proposed activities must, of necessity, be developed by Member States and with the assistance of WHO, ICSU and other competent international and national bodies.

Possible fields of action

(1) Comparative studies of the dynamics and adaptability characteristics of human populations, and the consequences of demographic changes on various environments.
(2) Systematic attempt at defining "carrying-capacities" in a number of socio-cultural settings and environments, perhaps through the development of models of carrying-capacities.

(3) Development of conceptual tools for assessing and evaluating policies relating to the numbers and distributions of people in various countries and regions.
(4) Preparation of recommendations concerning population-environment relations and programmes for use by governments and international organizations concerned with such problems.

PROJECT 13

PERCEPTION OF ENVIRONMENTAL QUALITY

The problem

The social, natural and man-made environments are closely related in the dimension of environmental quality. Approaching the question of environmental quality, man should be aware that he is himself a member of the biosphere, sharing the same roots with all other living beings and thus being in partnership with them. On the other hand, he has, because of his knowledge and power, the full responsibility for the biosphere. Empirical studies emphasize the importance of man's perception of the environment. The mutual interrelationship between humans and their environments can be isolated for separate discussion at different scales: e.g. in terms of personal space, large architectural space (aesthetics), roads and pathways, neighbourhoods, the city, larger conceptual regions (natural beauty and open space), and countries.

Perceptions vary with different cultural groups, each seeking to utilize the environment which they perceive in different ways.

Regardless of human preferences, certain environments set limits upon human numbers and forms of land use. The establishment of ecological and cultural criteria which can guide the shaping or modification of the environment is essential. Man can tolerate a wide but not unlimited range of environmental conditions. In order to establish the ratios and relationships between quality and quantity, sets of indicators need to be developed to plan for future changes.

The escalation of man's impact on the landscape due to the effects of technological advance and the diversity of circumstances imposed by physical constraints imply a flow of resources and a constant reinvestment thereof.

Effective methods of measuring the parameters, e.g. the effects of sensorial stimuli in urban and non-urban populations, is a formidable task requiring research which is interdisciplinary in nature.

Possible fields of action

(1) Analysis of perception of environment in different regions and cultures, to seek the major cultural determinants affecting environmental perception in various societies. This analysis should include different kinds of cultures, and might be approached, for example, through studies of:
  (a) perceptions of environmental hazards;
  (b) perceptions of visual or acoustic surroundings;
  (c) perceptions of landscape, in both its aesthetic and historic aspects, and in terms of its past or proposed remodelling by man.
(2) Cross-cultural studies of environmental preferences.
(3) Studies to establish socio-cultural and physical indices of environmental quality, with tests of their predictive effectiveness.

VI. INFRASTRUCTURE AND LOGISTICS

1. The Council considered that the research projects under the Programme would require the utilization of some kind of network of research facilities in areas representative of the significant subdivisions of the biosphere. It felt that these facilities would correspond to various levels of complexity and sophistication. Such facilities include what might be called research points, where simple measurements and observations could be made, research stations, where certain aspects of programmes of research could be implemented, research centres, where there are significant personnel and equipment resources available, etc.

2. In order to ensure the proper implementation of most scientific projects under the Programme, it will be necessary for each Member State participating in these projects to designate - or when necessary to establish - the research facilities required. Since many countries have already a variety of research centres, stations and organizations, it is not foreseen that there will be a need to establish many new facilities. It appears necessary, however, that the research capabilities of these existing institutions be brought to the proper level to enable them to participate effectively in the projects of interest to the country concerned. Since the majority of projects under the Programme are intended to be problem-oriented, the establishment or reinforcement of research facilities will be primarily directed towards the actual needs of participating countries.

3. The Council recognized that the nature of research and laboratory facilities available, or required, at any particular study site will depend, in part, on its accessibility. In remote areas, a self-contained field station may be needed to provide accommodation and laboratory facilities for research that needs to be done on site. In many countries, though, a large number of field projects may be undertaken by personnel who are continuously headquartered at their permanent university department or research establishment. These personnel may be conducting research in a variety of ecosystems not directly adjoined by a field station. Transport facilities are particularly important in this case.

4. The Council stressed that co-operation between research stations and centres on problems of common interest would be an important aspect of MAB. It recommended that, in order to stimulate such co-operation and to have a clearer picture of existing research facilities, particularly in developing countries, the Secretariat should invite Member States to complete a questionnaire on research centres and main stations in their own countries that were likely to play a significant rôle in MAB projects. It was recognized that such information was already available in some developed countries, and that in all countries the decision as to whether a particular centre or station would take part in MAB projects rested entirely with the country concerned. It was felt desirable, however, to conduct this survey as a useful tool for world-wide appreciation of the possibilities of implementation of MAB projects. It was also considered that the survey could show areas where new research facilities might usefully be developed or established. In the undertaking of this survey, full use should be made of previous related compilations.

The Council also felt that National Committees should, at an early stage, be invited to provide a synopsis of the plan of work being undertaken by each national project and a description of the site or area or problem being studied. In addition to a minimum site description, each National Committee might be asked to provide a description of existing experimental facilities and a listing of personnel and pertinent research papers.

5. The Council stressed that research could be conducted not only through the physical facilities such as those mentioned above, but also through other arrangements at the national level, such as committees, research units, workshops, expeditions, etc.

6. The Council reiterated that any effective study of international dimension on the structure, functioning and conservation of the biosphere and its component parts must necessarily be based on a set of comparable observations of various biological, physical and chemical, but also social and epidemiological, variables. This consideration implies, on the one hand, the organization in coherent networks of research points, stations or centres for specific projects, and, on the other hand, the development of comparable methods of measurement and observation.

7. In this regard, the Council recommended that comparability of results of research from all projects be ensured at the earliest possible stage. It felt that, in many instances, the experience already acquired under IBP should be used. It recommended that the Secretariat study this matter in co-operation with IBP and other appropriate organizations as soon as possible, and that the results of these studies be brought to the attention of National Committees and working groups and expert panels appointed for the formulation of detailed guidelines for projects under the Programme.

8. The Council felt that, as the Programme is implemented, it may be desirable in certain regions to develop or expand programme structures and facilities which would serve the needs of several countries in the region. Thus, for example, procedures for the processing and analysis of certain samples may be developed on a regional basis, especially where expensive equipment is required, where there are economies possible from large-scale operation or automation, or where uniformity and consistency call for it. In any region, there may be a number of laboratories with excellent capabilities which are not fully used. Arrangements may progressively be made to use such facilities for routine determinations for the whole region, wherever such procedure would be advantageous. Other programme services which might be developed on a regional or problem, or where appropriate global, basis, include arrangements for data storage and analysis, mapping, micro-nutrient analysis and taxonomic identification and verification. No definite recommendation can however be made at this early stage of the Programme. The Council felt, nevertheless, that the Unesco Field Science Offices had a special and immediate rôle to play in the promotion of regional and sub-regional activities. It also considered that co-operation should be developed with appropriate intergovernmental regional organizations interested in the Programme.

9. In many instances, research points, research stations or research centres are intrinsically connected with the particular environment in which they are located. These areas and sites will be of special value for research on the structure and functioning of the various ecological systems that comprise the biosphere. It would be desirable in particular that a number of research stations and research centres in various countries and continents dealing with problems of these particular systems be connected through the network arrangements. Such links will progressively be developed in the process of project implementation.

10. The Council also stressed the particular rôle of "biosphere reserves" as basic logistic resources for research where experiments can be repeated in the same places over periods of time, as areas for education and training, and as essential components for the study of many projects under the Programme. For this reason, as well as for the rôle which such reserves can play in the conservation of genetic material of wild plant and animal species, the Council recommended that each participating country designate "biosphere reserves" containing representative areas of each of the major or otherwise relevant ecosystems within the nation's boundaries. It further recommended that the Secretariat, in co-operation with IUCN, proceed with a study of general criteria for the establishment of such reserves.

11. The Council considered that, for conservation of various taxa and populations, the use of all modern techniques of gene resource storage and registry, including gene banks, should be encouraged. It invited the Secretariat to co-operate with FAO and IUCN in this respect. The Council felt at the same time that every encouragement should be given to the establishment and proper maintenance of botanical gardens. It further recommended that international assistance be provided for the preparation and publication of regional floras and faunas such as the Flora Neotropica.

12. The Council considered that it would be premature at this stage to recommend a world-wide effort within the MAB Programme for monitoring changes in terrestrial and fresh water environments, particularly since the needs and methodology for such permanent long-term observations had not yet been fully defined, and since the United Nations Conference in Stockholm would consider the general problem of environmental monitoring. If felt, however, that the networks of MAB research points, stations and centres which will be undertaking measurements and research on the functioning and carrying capacity of terrestrial and fresh water ecosystems, may in future years play a rôle in global or regional monitoring systems.

13. The Council considered the fundamental rôle of National Committees for the Programme. It recalled that the Programme is an international undertaking of scientific co-operation among Member States. The execution of the Programme is therefore primarily the responsibility of these Member States, while the international organizations concerned will provide the necessary stimulation and assistance required for such an undertaking. In order to ensure maximum national participation in the international programme, to define and implement this national participation, and to ensure liaison at the international level, every Member State requires a permanent and fully qualified organization.

14. The Council recommended that, as in the case of previous international scientific programmes, there should be in each country a National Committee for the Man and Biosphere Programme, to perform these functions. Although the establishment of such National Committees is a matter related to the internal organization of each country, some general principles may be suggested in this respect. It would appear most desirable, for

instance, that they be truly interdisciplinary with an interest in the major components of the Programme, that they be utilized to ensure the participation of the country in the Programme, and that they include both representatives of universities and research organizations on the one hand and representatives from technical government departments concerned on the other hand. Participation of representatives from agriculture, health and meteorology departments would in particular facilitate co-ordination at the national as well as the international level with such agencies as FAO, WHO and WMO. It will also be necessary to establish adequate liaison with existing National Committees for other international scientific programmes, such as those for the International Hydrological Decade or the International Biological Programme, which provide already an organized network of scientists concerned with the environment in many countries.

National Committees will formulate and recommend to their governments the precise content of their national programme, in the light of national priorities, practical possibilities and international requirements. The success of the international Programme will be greatly dependent on the efficiency, authority, composition and competence of National Committees. It is recommended that such committees be established as soon as possible by those Member States that have not already done so.

15. The Council considered that, in a number of cases, National Committees may wish to receive detailed comments and recommendations on the planning and organization of their national participation in projects under the Programme. The Council considered that MAB is a Programme which deals with the biosphere as the habitat of the human species as a whole and that its comprehensiveness on a global scale is a prerequisite for the fulfilment of its objectives. It felt in this respect that a number of countries may need international assistance in the building up of their scientific and organizational machinery necessary for their participation in the MAB Programme. It recommended, therefore, that such assistance be offered through bilateral or multilateral channels for the successful implementation of MAB projects. It also suggested the development of "pairing" relations between research organizations and National Committees as a means of assisting developing countries in their participation in the Programme.

The Council further recommended that the Secretariat of MAB be reinforced so as to be able to provide assistance to the National Committees in the elaboration of their programmes and in promoting contacts between National Committees. The organization of missions by experienced visiting specialists should also be arranged by the Secretariat, or otherwise.

16. The Council expressed the strong wish that UNDP assistance would be made available to support certain research and training activities related to the Programme, either on a national or regional basis, and that the institutions required for such research and training would receive full consideration at the same time. The Council invited the National Committees and participating Member States to give appropriate attention to this matter when formulating their requests for UNDP assistance. The Council also drew attention to the possibilities offered by other sources, including the United Nations Population Fund, for assistance to certain projects.

17. The Council invited Member States taking part in the United Nations Conference on the Human Environment to give proper consideration on the occasion of this Conference to the allocation of adequate international funds for environmental studies and training and particularly to projects related to the MAB Programme.

The Council invited the Director-General of Unesco to draw the full attention of the Stockholm Conference to the MAB Programme, as well as to other environmental activities of Unesco, to indicate the potentialities offered by the framework of the MAB Programme, and to underline the need for all countries to take full part in it.

VII. EDUCATION, TRAINING AND EXCHANGE OF INFORMATION

1. The Council considered that the Programme, to be fully effective, must be sufficiently supported through activities which will include formal training at different levels, as well as general educational measures, including the dissemination of relevant information to the general as well as the specialized public. The Council recognized that environmental education in general was a very broad subject which went much beyond the scope of the Programme itself and which would have to be handled by Unesco and other international organizations concerned through various means and channels. It felt however that, in view of the expanding scope and nature of the training and information activities in this field, the Council should establish the necessary organs to study these activities in relation to the Programme.

2. In order to assist the implementation of the above-mentioned activities at the national level, and to facilitate liaison between the different disciplines and professions concerned, the Council felt that National Committees for the MAB Programme might find it desirable to create sub-committees for education. Whenever feasible, these sub-committees should co-operate on a regional basis and might even be constituted on that basis.

3. The Council felt, furthermore, that a number of seminars and symposia might be promoted for the exchange of information among Member States on ongoing national experiments or actual breakthroughs in the field of interdisciplinary environmental education at all levels.

4. The Council considered that effective environmental education programmes must be based on the general world-wide needs in this field, as well as on the motivations and requirements in the different regions and countries concerned. Since there is a wide variation between countries, a series of regional surveys should be carried out, including consideration of curricula, evaluation of present facilities and provisions of the assistance necessary for the introduction of relevant ecological components into the present education programmes. The data gathered should be fully used to allow the widest possible comparison, periodic re-evaluation of trends and the periodic projections required for better planning. The Council recommended that a symposium on methodology of environmental education and on interdisciplinary approaches in education be organized in 1973, making use of the inquiries and studies being made by various departments of Unesco.

5. The basic aim of the education and training activities related to MAB will not only be to train the specialists needed for the implementation of the Programme. At the same time, it will be necessary to promote and stimulate interdisciplinary educational activities in ecology and the environmental and social sciences, at university level, in teacher's colleges, in primary and secondary schools, as well as in out-of-school education for youth and adults. Curricula for all levels of education also need to be revised, using "man and the environment" as the central theme. Environmental education should involve the appropriate integration of subject matter from the social and natural sciences into a unified curriculum, developed often within a new academic structure. In this context it was thought that the training of "generalists" in ecology would be of particular importance.

6. Certain education and training activities should concentrate on the education of non-specialists, both young and adult. The preparation of illustrated books for young children, which would stress man's harmony with, and responsibility for nature, should be encouraged. For the young, still at the level of the secondary school, it is recommended that governments consider the possibility of introducing into the curricula those scientific disciplines fundamental for understanding the natural environment and the principles of its rational management. Furthermore, in many countries it seems equally necessary to develop specialized forms of education for adults on the natural environment and its rational utilization. The special forms of such activities should take into account the ecological and social characteristics of a given country. Here advice and guidance may be proposed by the National Committee for MAB. Unesco should assist in these activities by providing necessary basic materials, such as the results of inquiries, educational materials and teaching aids. The Council also felt that the preparation of a fundamental sourcebook on the biosphere should be promoted by Unesco.

7. The Council recommended that specialized training for ecological research, including ecosystem studies as a basis for management, systems analysis, remote sensing, taxonomy and mapping

of ecosystems, receive special attention. The lack of specialists in these fields appears to be, and is likely to remain, one of the major obstacles to the development of the type of research activities which will constitute the core of the long-term Programme. The handbooks prepared under IBP will provide useful material for post-graduate studies. At the university level, both graduate and post-graduate, a major effort should be made to promote ecology and ecological thinking through the formulation and adaptation of the necessary teaching programmes covering the different disciplines involved and suited to the needs of the country. Particular stress should be placed on field training and the use of case studies.

8. Existing training centres and courses for post-graduate students in ecology, as well as courses in the integrated study and rational management of natural resources established with Unesco's support, should be further developed. Efforts should be made by governments and Unesco to organize new training courses within the framework of MAB. These would include a field work component and would take place preferably in developing countries.

9. Facilities for exchange of students between universities and training centres should be expanded through the provision of scholarships and fellowships, making use of the MAB machinery.

10. Special environmental teaching programmes and courses for engineers, architects, agriculturalists, foresters and other specialists, should be promoted. Particular attention should also be given to the introduction of ecology in the training of potential decision-makers such as economists, lawyers and administrators. Finally, efforts should be made to stimulate a proper concern of environmental problems and values in those presently responsible for policy and decision making.

11. The establishment of training centres and organization of special courses for field assistants and other technicians should be encouraged. The Council stressed in this connexion the lack of different types of technicians for supporting the recommended research projects in many countries.

12. A series of symposia focused on the natural and social sciences content of the Programme should be organized at an appropriate stage, so as to contribute to the development of knowledge, to promote the most active exchange of information, and to facilitate the continuous review of research directions and objectives.

13. The development and if necessary creation, at the highest attainable level, of multidisciplinary training and research centres in general environmental ecology should be promoted through the MAB machinery in various geographical regions. These centres should be promoted at local, national or multinational levels, with a view to the training of potential leaders in this field. Governments may apply to UNDP for financing such projects.

14. Regarding the general education of the public on the relationships between man and the biosphere, a series of out-of-school activities should be promoted where appropriate, by National Committees. These activities might include the preparation and production of relevant audio-visual materials in different languages, the strengthening - or creation if necessary - of national mass media centres, and the promotion of other pertinent activities (including objective radio and television programmes) which would lead to a public awareness of the need to actively participate in environmental matters. In this connexion, great care should be taken to ensure that information disseminated be based on sound scientific data. Assistance should be given to museums, national parks, botanical gardens and other relevant institutions in the adoption of more dynamic policies and programmes in the field of environmental education and information. Unesco could facilitate the communication and dissemination of objectives and well-documented information relevant to the MAB Programme.

15. Recognizing the present activities of youth for the improvement of environmental quality, co-operative programmes could be developed through MAB National Committees by providing arrangements through which students, young specialists, educators and youth leaders can participate in different environmental and conservation activities. These may be linked with research and operational projects, particularly in those field operations that would greatly benefit from the support of junior assistants and technical personnel. These activities may be complemented by training programmes for youth leaders and the publication of supporting materials, as well as the publication of research findings and the dissemination of information by all appropriate mass media.

Unesco should maintain and expand its activities, particularly in the Social Sciences area, with respect to the assistance provided upon request to Member States, and possibly to international organizations, for the interdisciplinary environmental training and ecological research necessary for evaluation of probable impact of development projects on the environment. The need for this kind of focus is particularly important in the training of development planners. This should be considered as an important adjunct to the successful implementation of the MAB Programme.

VIII. ORGANIZATION OF WORK AND SUBSIDIARY BODIES OF THE COUNCIL

1. The Council reviewed the general framework for the organization and implementation of the Programme at the international level, as it follows from its statutes and from the need for co-operation with other international agencies.

2. The Council felt that it would be premature to establish formal working groups at this stage. It was considered that this could not usefully be done until Member States had studied the recommendations of the first session of the Council and had defined the nature and extent of their participation in the Programme.

3. The Council considered, however, that there was need to convene, before the second session of the Council, a number of panels of experts, consisting of highly qualified specialists. These panels would, particularly, elaborate the scientific content of the projects recommended under the Programme, and consider the methodologies and plans of studies that might be recommended to National Committees for the implementation of these projects. This work would be undertaken in consultation with the relevant intergovernmental and non-governmental organizations concerned, and would take due account of the views expressed by Member States.

Another panel of experts should be convened to study the rôle of the systems and modelling approach in providing a conceptual framework and a means for integration of projects, forecasting of change and optimization of management.

A special panel of experts would study the nature and content of educational and training activities that should be promoted under the Programme.

The Council considered that decisions on the choice and number of panels of experts, as well as the order in which they should be convened, should be taken by the Bureau as early as possible. In making these decisions, the Bureau should take into account the urgency of the problem, the views and interests of Member States, as expressed in their comments on document 16 C/78 and in the discussions and decisions of the Council at its first session.

4. The Council also decided that an ad hoc working group should be convened late in 1972. This ad hoc group will include the members of the Bureau and the chairmen or representatives of the panels of experts mentioned above, as well as representatives of co-operating international organizations and other specialists that the Bureau might wish to invite. This ad hoc working group should formulate and co-ordinate proposals for the future work of the Programme, and should make recommendations on the number and terms of reference of working groups to the second session of the Council. These recommendations should take into account the conclusions of the panels of experts and the replies of Member States to the request from the Secretariat for their views on the report of the first session of the Council and intentions for participation in the projects recommended therein.

5. The Council recommended that its Bureau should meet as early as possible after the United Nations Conference on the Human Environment, in order to consider the implications for MAB of the decision taken there and to review the progress of work of the Secretariat. The Council further recommended that the Bureau should meet late in 1972 after the seventeenth session of the Unesco General Conference, in conjunction with the meeting of the ad hoc working group mentioned above. This meeting of the Bureau would also consider the organization of the second session of the Council.

6. Finally, the Council recommended that, in the interest of uniformity and to facilitate communications, the Programme be designated as "MAB" in the different languages.

IX. CONSULTATION AND CO-OPERATION WITH INTERNATIONAL GOVERNMENTAL AND NON-GOVERNMENTAL ORGANIZATIONS

1. The Council heard statements from the representatives of the United Nations Organization which take part in its work. A brief summary of these statements is given below.

2. United Nations

The representative of the United Nations expressed satisfaction that the spirit and substance of the projects which had been adopted by the Council were closely linked with many of the problems to be discussed in the broader framework of the United Nations Conference on the Human Environment. This showed, in the first place, a positive convergence of opinions on the approaches to be taken when dealing with the problems of the human environment. At the same time, and while it would be premature to forecast the outcome of the Conference, it seemed improbable that the Conference would recommend the creation of any new large United Nations agencies on aspects of the human environment. Rather, it seemed clear that most of the measures to be adopted in Stockholm would be carried out by existing United Nations agencies, working in co-operation with the competent governmental and non-governmental organizations. He therefore welcomed the activities that had been proposed by the Council for the Man and the Biosphere Programme as providing one of the potential means by which certain recommendations of the United Nations Conference might be channelled and implemented.

3. FAO

The representative of FAO reported that document 16 C/78 had been closely reviewed within FAO. He stated that FAO is not only interested in the programme, but is already deeply involved in several areas of it which lie within its own competence.

In noting that, from its inception, the Man and the Biosphere Programme had foreseen contribution and participation from other United Nations agencies and that in particular Unesco had expressed the wish to rely on FAO's contribution for the execution of some of the sub-programmes of Man and the Biosphere, he felt that there was a need to clarify further the ways and means by which the governing bodies of Unesco and FAO could jointly agree on the organizational and budgetary implications of such an operation.

He indicated that FAO foresees that the priorities and recommendations drawn up at the Stockholm Conference will lead United Nations agencies to reconsider large sections of their programmes. He noted that if Man and the Biosphere were to become a programme of common interest to several United Nations agencies, joint budgeting and joint operation may be required and this would have to be reflected in the Man and the Biosphere Programme organizational structure, in the elaboration of its sub-programmes and in its formal links with interested organizations.

It was understood, however, that Unesco and its governing bodies wanted to start implementation of some of the Man and the Biosphere sub-programmes as soon as possible. Since some of these may involve FAO's participation, he felt that both agencies could explore, for the time being on an ad-hoc basis, the possibility of arriving at some arrangements for initiating such sub-programmes. This would not raise major difficulties in these instances in which Man and the Biosphere sub-programmes relate to specific FAO proposals for its 1972-1973 Regular programme, as for example in the field of forestry. In the case of estuaries and coastal areas, it was necessary to take into account the LEPOR and FAO's collaboration with and support to IOC. In the case of fresh waters, FAO could foresee prospects for collaboration within the framework of Man and the Biosphere.

He drew attention to FAO's interests in the field of agricultural research and mentioned the Consultative Group in International Agricultural Research (sponsored jointly by the FAO, IBRD and UNDP), which is to play a major rôle in the implementation of agricultural research programmes, particularly those of the developing countries. Finally, he stated that FAO would like to co-operate and collaborate in Unesco's Man and the Biosphere Programme, as far is as possible and is permitted by its resource commitments.

4. WHO

The representative of WHO recalled the positive approach and keen interest of his Organization in the planning of Man and the Biosphere and its readiness to help in its implementation. He stressed that the interest of WHO was to exploit as much as possible the results of Man and the Biosphere for improving its long-term programme in environmental health. He expressed the hope that the new ecological knowledge that would be forthcoming under Man and the Biosphere would help to provide a more solid basis for WHO's major public health projects in various parts of the world. He stressed that WHO was eager to promote co-ordination of the multidisciplinary Man and the Biosphere projects, both at the national and international levels. At the national level this could be achieved through the input of medical expertise into Man and the Biosphere national committees. At the international level this would imply the development of procedures for inter-agency consultation and co-operation, possibly through an inter-agency advisory group attached to the Man and the Biosphere Co-ordinating Council or, preferably, through the establishment of a small ACC functional group for the Man and the Biosphere Programme.

He particularly emphasized the importance of the long-term effects of different concentrations of environmental pollutants and of different levels of environmental change on man's health and well-being, for which WHO had professional responsibility, but where Man and the Biosphere could play a useful rôle. He also stressed the interest of geographical studies of human genetics and reproduction.

5. WMO

The representative of WMO noted that weather and climate were common elements in the scientific approach to several of the projects outlined in the Man and the Biosphere Programme. He felt it important that experts in meteorology and climatology were attached to these projects at the national level, in order to ensure the use of appropriate methods. He commented that WMO could be helpful in opening the appropriate channels to obtain this expertise at the national level.

He also drew attention to the work of the inter-agency (FAO/UNESCO/WMO/UNDP) co-ordinating group which had for several years been promoting studies on agricultural biometeorology at the national and regional levels. He hoped that this group might be asked to ensure that agrobiometeorological approaches are sufficiently taken into consideration in the relevant Man and the Biosphere projects, and to propose specific studies and surveys on this subject which would support the Man and the Biosphere Programme.

6. The Council was pleased to be informed of the co-operative approach of the United Nations organizations concerned to the Man and the Biosphere Programme, and welcomed the various offers they made to participate actively in its further formulation and in its implementation. It stressed the need for flexible inter-agency arrangements which would not only avoid any possible duplication of efforts, but ensure progressively a more active participation of the United Nations agencies in the programme. It welcomed in this connexion the consultations which had already taken place and were contemplated in the near future.

7. The Council also heard statements from the representatives of the international non-governmental organizations which take part in its work. A brief summary of these statements is given below:

8. ICSU

The Chairman of the Scientific Committee on Problems of the Environment (SCOPE) recalled the desirability underlined by the Assistant Director-General for Science for close liaison between Man and the Biosphere and SCOPE, and reaffirmed the desire of SCOPE to establish such a liaison. He indicated that SCOPE could receive commissions from Man and the Biosphere for the development of advice in relation to certain Man and the Biosphere projects, and that Mnn and the Biosphere might also wish to indicate complementary fields of research which SCOPE could undertake. At the same time, SCOPE had in mind the initiation of its own programme and the development of research in which it can have a direct and continu- interest.

The Secretary-General of ICSU stated that the officers of ICSU had accepted the idea of a joint Unesco-ICSU Committee for Man and the Biosphere, and would be making proposals concerning the ICSU membership of this committee to Unesco. In commenting that ICSU would always be willing to advise the Council within its fields of competence, he drew attention to some of the work of ICSU undertaken within the framework of SCIBP, SCOPE, SCOR or SCAR, which related directly to the research proposals made for Man and the Biosphere and which might prove valuable in the implementation of the programme. Finally, he reported that ICSU would be willing to assist in co-ordinating its relevant programmes with those of Man and the Biosphere, so as to avoid unnecessary duplication, and to provide the maximum support from the world scientific community in order to help ensure the success of the Man and the Biosphere Programme.

9. IUCN

The representative of IUCN reported that document 16 C/78 had been widely circulated among IUCN specialists, who showed considerable support for the programme. He expressed satisfaction with the projects that had been defined by the Council, and which were in full agreement with the basic aims of IUCN. He commented that many ongoing and planned activities of IUCN appeared to be of direct significance and importance to certain Man and the Biosphere projects. He noted that the implementation of some of these IUCN activities depended on the availability of funds, and hoped that some of these might flow through Unesco in relation to the Man and the Biosphere Programme. Finally, he stated that IUCN would be happy to participate in the panels and working groups established under the Programme, and suggested that procedures for liaison between Unesco and IUCN on the Man and the Biosphere Programme should be further developed.

10. The Council was pleased to be informed of the willingness of these organizations to cooperate fully in the programme and to give it appropriate scientific advice. It welcomed the proposed establishment of a Unesco-ICSU liaison committee for Man and the Biosphere, as well as the development of liaison arrangements for Man and the Biosphere between Unesco and IUCN.

11. The Council accepted the proposal that, in planning and organizing the Man and the Biosphere Programme, it endeavours to make appropriate and widest use of the capabilities of intergovernmental and non-governmental organizations engaged in, or planning, activities directly related to the objectives and content of the Man and the Biosphere Programme.

ANNEX I

INAUGURAL MESSAGE OF MR. RENE MAHEU DIRECTOR-GENERAL OF UNESCO*

Your Excellencies,
Ladies and Gentlemen,

It gives me particular pleasure to welcome the distinguished delegates who are about to take part here in the work of the first session of the International Co-ordinating Council of the Programme on Man and the Biosphere.

It was the General Conference of Unesco, at its sixteenth session, which decided, by adopting resolution 2.313, to launch this Programme and to establish your Council.

As you know, this important decision, taken unanimously, was not in any way a hasty sign of a sudden awakening to the problems of the human environment, of the sort which has become so common today. It was, on the contrary, the fruit of a long evolution going back to the very beginnings of Unesco. Now that we are celebrating the Organization's 25th anniversary, we can scarcely fail to remember that, under the perspicacious guidance of its first Director-General, Julian Huxley, the scientific study of natural resources and their conservation was, from the outset, included in its programme. Nor can we fail to mention the fact that it was under Unesco's auspices that the International Union for Conservation of Nature and Natural Resources was founded in 1948 at Fontainebleau. Twenty years later, in 1968, together with the United Nations, the Food and Agriculture Organization, the World Health Organization, and in co-operation with the International Biological Programme of the International Council of Scientific Unions and the International Union for Conservation of Nature, Unesco convened in Paris an Intergovernmental Conference of experts on the scientific basis for rational use and conservation of the resources of the biosphere. Out of this Conference, after many studies and consultations, came the Programme on whose broad outlines you are now called upon to decide. Between these two dates, 1948 to 1968, Unesco was constantly preparing and carrying out programmes bearing on the same essential themes. In the Major Project on Scientific Research on Arid Lands, in the work co-ordinated under the International Hydrological Decade or the Intergovernmental Oceanographic Commission, and again in the very recent International Geological Correlation Programme, we find everythere the desire to direct international scientific co-operation towards the achievement of a better knowledge, and hence, a more enlightened use of the natural resources on which the survival of mankind depends.

The Programme on Man and the Biosphere is thus the product of efforts and concerns which have constantly engaged Unesco. It is true, however, that this Programme includes and introduces a new dimension, in the sense that it is man himself, considered in his relationship to the natural environment, who is, in fact, the central subject of study.

It is obvious that, with such a subject, the Programme might easily tend to be more ambitious than the means we can hope to command for carrying it out would warrant. It must therefore be strictly delimited from the outset, with due regard for the framework approved by the General Conference. This, in my opinion, is your chief task. As you know, the General Conference decided that the Programme should focus "on the general study of the structure and functioning of the biosphere and its ecological regions, on the systematic observation of the changes brought about by man in the biosphere and its resources, on the study of the overall effects of these changes upon the human species itself, and on the education and information to be provided on these subjects". In the light of the observations received from Member States, you are now required to lay down the main lines to be followed in this Programme.

In so doing, you will be able to take as your starting point document 16 C/78, to which the General Conference itself referred in considering the question. This document was drawn up after extensive consultation both with scientists and with the governments and international organizations concerned. It was the product of a great effort at consolidation but still contained a large number of widely varying proposals. It was for that reason that the General Conference wished priorities to be established and a selection to be made from among the research themes suggested.

For this purpose, I had fresh consultations with Member States, the results of which are now

* Original French.

before you, together with suggestions from the competent international scientific organizations. In addition, nearly forty National Committees have already been set up in pursuance of the relevant resolution of the General Conference; and in many countries, these bodies or ad hoc committees established by the National Commissions for Unesco, have studied the content of the Programme in detail in order to determine its essential components. Complete agreement in the opinions expressed could obviously not be expected, but a general trend seems to be apparent which I should like to try to outline briefly.

In the main, Member States and organizations alike seem to view the Programme as a means of mobilizing the energies of the international scientific community for the purpose of defining fundamental ecological principles for the more rational use and better conservation of the resources of the biosphere, for improving the general relationship between man and his environment, and, lastly, for foreseeing the consequences of his present actions for the world tomorrow. Confronted with what has been called the environment crisis, which is at bottom, primarily a crisis of civilization, countries seem to want objective studies to be carried out that will make it possible on the one hand, to form an accurate idea of the situation throughout the world, in all its geographical complexity and, on the other, to discover how mankind can derive the utmost possible advantage from that situation without jeopardizing its own future.

Even once this is established, I realize that it will probably not be easy for you to define with all the accuracy desired what the Programme in its initial phase should comprise. You will have to show great wisdom in deciding which research projects should have priority, and courage in rejecting others which may be dear to some of you. I should therefore like to draw your attention to a few considerations which may, I think, be of assistance to you in your difficult task.

In the first place - and I must stress this point - Unesco is not the only organization dealing with the questions concerning man and the biosphere. It must be careful, in particular, not to engage in activities that could be carried out more efficiently by other agencies. On the other hand, Unesco knows that it can count on the co-operation of the other United Nations agencies interested as well as of the competent international scientific organizations.

Secondly, the programme that you are going to define cannot embrace all the activities that Unesco is called upon to conduct as far as the environment is concerned, principally because some of these activities come under already existing intergovernmental programmes, as for instance in hydrology and oceanography, with which the necessary co-ordination simply has to be secured.

Lastly, as this is a venture in international co-operation for which certain machinery is being provided, the programme components to be selected should be particularly suitable for this machinery to handle. There are limits to what can be expected of any particular instrument.

Other criteria may also guide you in making your selection. You may, for example, be interested in acquainting yourselves with the criteria that the Advisory Committee on Natural Resources Research laid down for you at its last session, held in Canberra in August. You will also wish to direct your attention to the specialized studies that the International Biological Programme has already carried out and that it may be well to follow up and develop in the context of your intergovernmental Programme.

Whatever choices you may make, you will certainly not want this Programme to be simply a catalogue of activities to be followed slavishly during the years ahead, but rather an overall plan - a coherent but flexible and above all realistic plan, which will take into account the interests and resources of the governments and other bodies that will be called upon to bear the main costs of carrying it out. Lastly, you will, I am sure, see to it that it is universal in scope by ensuring that all countries, whatever their position and degree of development, may take part in its execution.

Ladies and Gentlemen,

Your first session is being held at a crucial moment. On the one hand, the anxiety caused by the problems relating to the environment will be given definite expression, as far as the general policy of the international community is concerned, at the United Nations Conference to be held in Stockholm in June 1972: it would, I believe, be of the greatest value if you were to define here and now a scientific programme calculated to gain acceptance in responsible quarters so that it would receive at Stockholm the political and economic backing needed for carrying it into effect.

Although your work will bear mainly on the content of the Programme, it will also be your task to define the methods and structures required for its implementation, in co-operation with the other international scientific programmes to which by the nature of things it is linked. On the basis of the working documents prepared for you by the Secretariat, you will also be called upon to study the logistic aspects of the execution of projects and the fundamental operations they necessitate. Lastly, you will have to decide on the type, terms of reference and number of subsidiary organs - working groups or panels of experts - to which you may wish to entrust the technical preparation of certain projects or groups of projects. In this connexion, experience shows that it is to the interest of a Council such as yours to maintain as far as possible its freedom of action and not to burden itself with over-complex sub-structures which are liable to add to the overhead expenses of the Programme and increase the volume of documents, without contributing to the effective development of specific research activities.

The recommendations that you will adopt at the close of your discussions will be communicated to Member States, National Committees and all the international institutions concerned, whether governmental or non-governmental. You will, of course, pay particular attention to wording these recommendations precisely. Member States expect to receive from you guidelines, even detailed directives, on which they can draw in establishing their national plans of action and organizing an effective co-ordination of the activities proposed under the Programme.

These, Ladies and Gentlemen, are the tasks with which the General Conference has entrusted you. Aware of their immense significance for the well-being, even for the very survival, of mankind, you will, I am convinced spare no effort to carry them through. It is therefore with the utmost sincerity that, on behalf of the Organization and on my own behalf, I ask you to accept the warmest wishes for the success of your work.

ANNEX II

SELECTION FROM WORKING DOCUMENTS

II. 1 ASPECTS OF THE STUDY OF ECOSYSTEM STRUCTURE AND FUNCTIONING

The following paragraphs, adapted from document 16 C/78 and directed essentially to non-specialists, are intended to supplement the information given in Chapter IV of the report, entitled Scientific Approach of the Programme. They outline, in very general terms, certain aspects of the study of the structure, functioning and dynamics of ecosystems which are implicit in much of the research called for in the 13 scientific projects established by the Council.

Analysis of ecosystems

The potential biological productivity of ecosystems depends on the flow of incident radiant energy from the sun and on the way in which this energy is transferred and transformed within the biosphere: reflected by the surface of the soil and the vegetation, converted into chemical energy through photosynthesis or into sensible or latent heat, stored in some converted form in the biomass and the soil for various time periods, etc. These transters and transformations of energy, together with other environmental factors, determine to a large extent the upper limit of production in optimal conditions of water and nutrient availability.

Ecosystem research includes the description of abiotic variables, the inventory of biotic components and studies on the biology and physiology of selected species. It also involves the study of the various states of different types of ecosystems, to determine the interrelationships between structure and functioning and to determine the variability and magnitude of rates of energy flow and nutrient cycling. Attention is also given to the changes in certain parameters of ecosystems over time, to the ways in which social interactions affect ecosystem processes, to the driving forces that make different ecosystem types operate, and to the relations between diversity and stability.

Wherever possible, work is undertaken within an overall systems framework and includes the development of procedures for accurately predicting the consequences of environmental stresses, both man-originated and natural, on the performance of ecological systems.

The general approach is to concentrate on intense study of a few carefully-selected ecosystems, thus involving the deployment of co-ordinated, interdisciplinary research teams to focus integrated attacks on precisely defined problems. It is clear that we cannot learn all about everything in selected ecosystems representative of the major biome types, so that priorities and critical assessment have to be given to each component in each project undertaken.

Photosynthesis, growth and primary productivity

The capacity of the biosphere to preserve its functional structure is due primarily to the process of photosynthesis. Photosynthesis is the basis of primary production which, in turn, is the starting point of all the other biological processes in the world. The resulting quantity of plant biomass depends on the amount of radiant energy converted to chemical energy by photosynthesis and, perhaps more important, on the way in which the products of photosynthesis are utilized to build up the functional structure of the plant. This structure is the essential factor in determining the quantity of solar energy which is intercepted and used for photosynthesis and the quantity used by respiration.

For this reason, there is an increasing tendency to combine studies on photosynthesis, respiration and growth in ecological research. This is moreover justified from a physiological point of view since numerous feed-back mechanisms exist between these three processes. There is also a growing tendency for closer collaboration between specialists working in laboratory conditions (e.g. those using controlled environment growth chambers) and those working in field conditions (e.g. those using environment controlled cuvettes and micro-meteorological techniques).

In the promotion of simultaneous studies of photosynthesis, respiration and growth in relation to the various environmental factors prevailing in different biomes, the following aspects should be stressed: the dynamics of the structure of the photosynthetic system; the rate of respiration in the processes of growth and storage; the distribution and translocation of photosynthetic products in the plant and in relation to its reproduction; the effect of the water status of the plant on the functioning of the photosynthetic system.

Plant-soil-air-water relationship

The relationship between water, air, soils and plants depends on a series of mechanisms which it is absolutely necessary to understand if high levels of productivity are to be maintained on a long-term basis. With this objective in view, the exploitation of the biosphere should not only be judged by crop yield but also by changes in managed, modified ecosystems. In this respect the following are of primary importance: water needs and consumption of plants; influence of root systems on the physical and chemical properties of soils, exportation and storage of mineral elements by plants and the return of mineral elements to the soils.

Any modification of the activities and habitats of soil reducers and decomposers is reflected in changes in rates of mineral turnover. It is therefore necessary to consider the use of different cultural techniques for initiating or maintaining crops which affect the soil climate and thus influence the activities of micro-organisms. Edaphic factors which reduce the ionic exchanges between soil and roots constitute a bottle-neck in the cycling of biogenic elements, often resulting in a loss of fertility. Even the smallest regressive change in the total process of humification has rapid repercussions throughout the whole ecosystem. Moreover, the mobility and absorption of minerals are slowed down if other metabolic regulators, such as water and air content, become deficient.

From the viewpoint of agricultural biometeorology, a better understanding of plant-environment relationships will lead to significant progress in solving such problems as: the choice of crops and methods of land management; the determination of factors limiting production; the more efficient use of fertilizers and water; the diversification of agriculture in a given place through the introduction of the range of crops best adapted to the particular environmental conditions; and the forecasting of harvests.

Distribution and cycling of important elements

In the biosphere the elements follow cycles which manifest themselves in rock weathering, soil formation, plant growth, the synthesis, metabolism and decomposition of organic matter and the uptake of these chemical elements by water during its own cycle. These elements can therefore migrate, accumulate, displace themselves from one environment, and reappear in another, etc.

The normal biogeochemical cycles found in the biosphere are intimately bound to the existing environmental conditions, whether on a local or regional scale. These normal cycles lead to situations varying from total absence of some elements in certain cases (e.g. leaching of basic elements in a humid tropical climate) to concentration of elements to toxicity level in others (e.g. salinization phenomena). Somewhere between these extremes there exists an optimum concentration of each element, according to prevailing conditions, with regard to environmental productivity and favourable "biogeochemical types".

By utilizing, modifying and consuming the resources of the biosphere, man constitutes a major factor in biogeochemical cycles. He affects them by taking out elements (harvesting and cropping), by putting back others (fertilization), by changing the hydrological cycle (drainage, irrigation, dams) and by introducing into the ecosystems substances resulting from his activities which may influence the cycle of other elements. In short, agricultural and industrial activity greatly modify the normal biogeochemical cycles of elements and it is essential to know more about these cycles, as well as their changes and consequences, in order to establish more rational procedures for the utilization of natural resources.

Work on this subject may involve the analysis of relationships between biogeochemical cycles and long-term ecosystem stability, and the promotion of research in various climatic and edaphic zones on the migration and cycling of useful elements.

Decomposer organisms and recycling processes

Decomposer and detritus organisms, particularly bacteria, fungi, protozoa and small invertebrates, play an important rôle in soil and fresh-water fertility and the renewability of resources of the biosphere. Their natural recycling activities and their enriching of the soil (mineral-fixation, improvement of the soil structure) are often impaired by the abiotic and biotic changes deliberately or accidentally brought about by man.

Disruption of the ecology and normal functioning of the soil organisms may result in impaired natural fertility of soil both in natural and artificial ecosystems or lead to population outbreaks which can cause important damage. In this connexion the qualitative and quantitative effects of pollution on species composition, population dynamics, food chains and recycling capacities of soil organisms deserve a special consideration, particularly if a global understanding of ecosystem functioning is aimed at.

Rôle of consumers in ecosystem dynamics

Consumers play an important rôle in many ecosystems, especially in situations when man is an integral part of the ecosystem, both as the top consumer and prime manipulator.

Consumer populations tend to vary greatly both in time and space and hence their impact on other ecosystem components varies considerably. These variations make evaluation of the rôle of consumers very difficult, although these very fluctuations can serve useful purposes in ecosystem analysis by providing different levels of consumer pressures.

The efficiency of secondary production processes depends greatly on the stability of different communities, linked with the diversity of species, their number and their repartition along trophic chains. It is also influenced by the speed at which nutrient elements are being taken up or re-used. Our present knowledge of the ecological efficiencies of different consumer groups and the effect of consumers on the distribution and availability of chemical elements is, to say the least, sketchy for most regions of the world. Elucidation of the structure, performance and interrelations of consumer populations is not only of great intrinsic interest, but will provide a much more solid basis for the optimal management of many ecosystems.

The importance of a particular consumer in ecosystem functioning of of course not necessarily reflected in the size of its calorie uptake, and selective consumption of a specific food source at a particular time may have far-reaching repercussions on ecosystem balance. One practical manifestation of this is biological control which can provide a long-term effective means of action against pest species without the undesirable side effects often attendant with chemical control.

Rôle of introduced species in ecosystem functioning and stability

A feature of man's colonization and exploitation of the biosphere has been the disruption of existing patterns of species abundance and distribution. The change from natural diversity to monoculture and the introduction of exotic species has resulted in imbalances between populations and the environment, as well as more desirable increases in resource utilization. The introduction by man of exotics has often been undertaken without a sound appreciation of all the factors involved, and not surprisingly this has led to both desirable and undesirable results.

The influence of man on species distributions is not only confined to deliberate introductions. Of equal importance are those introductions which occur as a result of man's mobility and his ability to drastically reorganize the boundaries of biosphere components. It is important to ensure that ecological consequences related to species distribution and abundance are fully considered in the planning of the many major development projects now contemplated or proposed.

II.2 ECOSYSTEM MODELLING

(Adaptation of a working paper prepared for the first session of the International Co-ordinating Council)

Introduction

In pursuit of its objectives, the Man and the Biosphere Programme will be deeply concerned with the functioning and dynamics of ecosystems. Ecosystems are distinguishable portions of the biosphere functioning to some extent independently of one another. Each ecosystem consists of the plants, animals and micro-organisms occupying a definable portion of the earth's surface, together with the relevant features of their abiotic environment; it is usually in some sense homogeneous at the scale considered. Landscape units - a drainage basin, a mountain range, a town and the rural area associated with it - generally are at a higher level of complexity again, and may be considered as a mosaic of different types of ecosystems arranged in a definable spatial pattern. These mosaics combine at a still higher level of complexity to form the biosphere, the tenuous shell surrounding spaceship earth within which man moves and has his being.

An ecosystem should not be thought of as a definite and permanent collection of organisms and their habitat. Though most terrestrial plants, micro-organisms, and some animal groups are permanently associated with a particular ecosystem which may be defined spatially, there are many animals which move freely between adjacent ecosystems. Each of these animals is then a part-time constituent of several ecosystems and may serve as an agent of interaction between them. Likewise, movement of the abiotic constituents - air and water - may bring about exchanges between contiguous ecosystems.

Man is one of the constituents of the ecosystems in which he finds himself - usually a part-time constituent of several - like the animals mentioned in the previous paragraph. Like other organisms, he interacts with the other components of the ecosystems, affects them, and is affected by them. These interactions constitute an important part of the Man and the Biosphere Programme. In order that man should learn to live in, and to maintain the quality of his environment - in order that the ecosystems of which he forms part should remain capable of supporting his continued presence and maintain their vital structure - it is essential for him to understand the driving forces of these ecosystems, their dynamics, and the mechanisms by which they are regulated.

To step into the driving seat of a car and operate the controls without previous instruction as to their effects on the whole system would be to invite disaster. To attempt to manipulate ecosystems - far greater in complexity, far more difficult to understand, than a man-built mechanism - without prior knowledge of the probable effects of one's actions would be equally perilous.

An ecosystem - whether or not under manipulation by man - is one of the most complex objects with which human thought has to deal. It contains a great multiplicity of objects, each of which individually constitutes a system of a lower order whose intricacies remain to be mastered, no two of which are strictly identical, and many of which are mobile within a system where spatial interrelations may be of considerable importance. Intuition is of little avail in considering systems characterized by great complexity of interactions and a multiplicity of feed-back mechanisms. An adequate understanding of such systems calls for tools and techniques of a higher order than those appropriate to simpler systems such as those with which the engineer ordinarily deals.

Systems ecology

In recent years, there has been extensive study of the behaviour of complex interacting systems in such fields as engineering, physiology, sociology, economics and geography. This work has depended heavily on the use of electronic computers, and is based on computer simulation or modelling of the systems studied. Some of the more ambitious studies have attempted to model complete regions, or even the whole world.

Drawing on, and building upon, this diverse body of experience, progress has been made over the past ten years in the development of methods for understanding the dynamics of ecosystems and the impact of stresses upon them - including stresses generated by man. These methods are subsumed under the heading of "systems ecology".

Systems ecology is based on the assumption that the state of an ecosystem at any particular time can be expressed quantitatively, and that changes in the system can be described by mathematical expressions, determinate or stochastic. Where this assumption applies, a quantitative knowledge of the state of the system at one time provides a basis for describing in quantitative terms the state of the system at some later time, with or without a penumbra of uncertainty due to random processes, so long as the values of relevant variables not generated within the system (exogenous or driving variables) are known during this interval.

Commonly, the mathematical expressions describing the rates of change in the different state variables of the system, in terms of the factors infliencing them, take the form of differential equations. These are built into a computer programme, and the computer is supplied as input with the initial values of the state variables, the time course of exogenous variables, and the time interval over which a prediction is required. The computer then proceeds to a numerical solution of the set of equations over the time interval specified, and reports as output the new values of the variables describing the state of the system. This, then, is a simulation model of the ecosystem - a representation of the ecosystem and the processes within it simplified in such a way that the behaviour of the system as a whole in time can be simulated.

Computer modelling and simulation of ecosystems

The computer plays an essential rôle in this process in more than one sense. The solution of the differential equations would generally be impossible analytically - ecosystem processes are often highly non-linear - and extremely laborious by numerical methods without its aid. It is necessary to keep track of a large number of variables simultaneously, which presents no difficulty to a modern computer with abundant storage, but would be difficult without it. And the calculations involved, even in a much simplified representation of an ecosystem, would be so numerous as to preclude the general use of this approach except for the availability of computers. A set of equations representing the changes in an ecosystem, including perhaps several dozen variables, can be solved in a fraction of a second, so that the time-scale for this dynamic model may be less by five or six orders of magnitude than that of the real-life system it represents.

An ecosystem model does not spring ready for action from the head of an investigator. The computer model is preceded by a logical model, based on a systematic study of the ecosystem, and incorporating the best biological knowledge available. Sub-models are developed, into which the mechanisms of particular processes are incorporated. Only when these earlier stages have been completed, and the sub-models have been satisfactorily tested, can they be put together into a model of the whole ecosystem with reasonable hope that it will behave realistically.

It should not be thought that modelling is a substitute for empirical studies. An ecosystem model can be no better than the data base on which it is built. Rough-and-ready models can be built on a very slim data base; but the body of quantitative ecological knowledge available at present is generally too scanty to provide effective prediction capabilities. The data base must accordingly be expanded; practical observations in field and laboratory are required to provide the understanding of mechanisms needed for model building, and to test the performance of models and sub-models. But the modelling process, providing an insight into the interrelationships within the system, can afford a valuable means for guiding and integrating the empirical work. If practical and modelling studies go hand in hand, there is an excellent chance that models providing an effective capacity for prediction can be made available without undue delay.

It will readily be seen that the crucial part of ecosystem modelling lies in the sub-models. Each will simulate a particular sub-set of processes within a distinguishable sub-system - as, for instance, nitrogen transformations in the soil; water transfer between soil, plant and air; predation; seed germination; or direct interactions between man and the biota. The sub-models will in general deal with processes on a shorter time-scale than is required for the model as a whole, and their structure should reflect a sound biological (or physical) understanding of their subject matter.

Application of ecosystem models to the rational use of natural resources

Once such a model has been built and tested, it can be used as a guide to rational use and management. If it is intended to modify the ecosystem in some way, the effects of this modification can be tested on the model far more quickly and cheaply than in the real-life system, and without the risk that unexpected effects will have embarrassing and irreparable repercussions. If it is desired to manage the ecosystem to attain some specifiable goal - such as maximum water yield, minimal loss of surface soil consistent with a given grazing pressure, or maximum stable wild-life biomass - the simulation model could be incorporated into a computer programme designed to test all possible combinations of management practices, and hence optimize the results in the sense specified.

The unit with which one is concerned in land-use management is usually a complex of ecosystems - such, for instance, as is contained within a drain age basin. Simulation models can also be of value at this higher level of integration. If models are available of the separate ecosystems, together with their spatial interrelationships, and if the way in which outputs of one become inputs to another is known, the separate ecosystem models can be combined to give a model of the whole complex.

As examples of the type of model potentially or actually applicable to decisions concerned with the rational use of natural resources, one may mention those determining strategy for the control of insect pests of forests; those exploring the effects of phosphate release into streams; those guiding grazing management in arid shrublands and those describing the probable distribution of, and hazards from, radionuclides if nuclear explosives were used in cutting a sea-level canal through Central America.

Such developments are as yet in their early stages. A number of ecosystem models have been built, and have been shown to behave realistically over a period of a few years. In very few cases have quantitative comparisons been made between the results of computer models and observations in the real-life systems they represent. But one may predict with confidence that numerous such comparisons will come to hand during the coming five years; that expertise in the field of ecosystem modelling will rapidly expand; and that the need for assistance from this source to the rational use and conservation of natural resources will develop even more rapidly.

Ecosystem modelling has great practical potential in the management of natural resources, as indicated above. Wherever alternative land-use and management policies are under discussion, choice between them could be greatly facilitated by a reliable dynamic model. It need not be supposed, however, that a single model of a system will serve all purposes. The scale of the model in time and space will need to be adjusted to the particular problem. The detail and resolution required in different parts of the model will vary according to their immediate relevance. If one is primarily concerned to predict changes to herbivore populations, for instance, that part of the model dealing with soil compaction can be painted with a broad brush; if on the other hand the primary purpose of the model is prediction of runoff, this part will require more detail but herbivore demography can be tested cursorily. Even though each model required to answer a particular management question is likely to be built ad hoc, it will in general be possible to put it together from a number of general-purpose modules, each dealing with a small sub-set of processes in a particular part of the system, which may be selected from a library of sub-models maintained for this purpose.

Experience in ecosystem modelling is at present limited to a few centres in the highly industrialized countries. It demands a combination of good computer facilities with a team of ecologists who have both a broad ecosystem approach and quantitative interests, and the number of really active centres can be counted on the fingers of two hands. The need for a firm basis of biological knowledge and understanding in such enterprises should be emphasized. Their success depends greatly on the extent to which the modelling team can keep its feet on the ground of biological reality. Otherwise, there is a serious risk that the tail may wag the dog - that the intrinsic interest of the theoretical problems of modelling and computer simulation may lead the team away from the primary objective of ecological prediction.

Ecosystem modelling in training and research

Apart from its value as a tool for management and rational use, ecosystem modelling can play important integrating rôles in ecological training and research. The building of an ecosystem model inevitably directs attention in turn to all aspects of the ecosystem and its functioning, and to lacunae in knowledge which might otherwise have been ignored. It is possible for a specialist involved in this experience to remain oblivious of the interaction of his own special subject with all the other components of the system, for model building makes these interactions very explicit. Experience in ecosystem modelling can accordingly be of great value in the training of an ecologist, enforcing breadth of outlook and restraining tendencies to undue specialization.

In research, an ecosystem model can serve as a means for planning and executing integrated programmes which can be divided into discreet portions, some perhaps quite simple, for execution separately. Where similar systems occur in different territories or continents, a model may facilitate the extrapolation of the results of research in one area to another, or indicate complementary programmes of research required to make existing results applicable in a new area.

Ecosystem modelling in the MAB Programme

All these possible uses of ecosystem modelling - in research, training and rational use - are likely to be needed in the Man and the Biosphere Programme.

A central part of the plan for the Man and the Biosphere Programme is to study the structure and functioning of the biosphere. The relevance of ecosystem modelling here is obvious. An effective model must embody a very deep understanding of the functioning of the system. And many aspects of the structure of ecosystems must be understood in order to account for the way in which they function. The test of the validity of a dynamic model is that it can give effective prediction. This is also the touchstone of a full understanding. If one understands the functioning of a complex system, one can predict the effects of stresses upon it. If one is unable to make such predictions, one's understanding is faulty.

A second component of the Programme is the study of how man may modify the biosphere without causing breakdown in its equilibria. For this goal, too, it is clear that ecosystem modelling may be able to play a major rôle. As explained in previous paragraphs, much of the current effort in ecosystem modelling is directed to this purpose, and at present it seems the most promising approach for getting answers of this sort without expensive field experiments of long duration, and without irreparable disturbance of existing ecosystems.

The third part of the Programme - the impact on man of the environments he has created - is also likely to benefit considerably from modelling and a systems approach. Though ecosystem modelling as such is not likely to have a direct rôle to play here, its influence on this part of the Programme may also be substantial.

It is to be hoped that study of the biosphere will lead to a critical awareness - both in the decision-making agencies of governments, and in the public at large - of the alternative futures for mankind which the complex environment makes possible. Analysis, understanding, prediction and decisions about separate parts of the biosphere must become more widely recognized as leading to integrated conclusions about the whole biosphere, which a piecemeal approach is unlikely to provide. Long-range planning should include biosphere models at least of a skeleton type, which will enable results from regional models to be integrated. For instance, without such a framework the rôle of the biosphere in effecting a carbon-dioxide equilibrium with the atmosphere cannot be satisfactorily appreciated. Without integrated results from ecosystem studies in quite diverse regions, neither data nor models will be available when they are required to help guide policy decisions on such matters as land use, pollution and energy sources, or even priorities for more detailed modelling work.

Conclusion

Accordingly, there would seem to be a need to develop activities for rapid and widespread training in the principles of systems ecology. It is highly desirable that the number of centres where active studies in this field are in progress should be substantially increased - and in particular that such centres should be established in parts of the world at present lacking this experience. But even more important is that understanding of the principles involved should be widely disseminated far outside the ranks of active practitioners - in fact, throughout the professions to which ecology is relevant. So long as the man concerned with ecological studies in the field and with the management and rational use of natural resources can talk uninhibitedly with the man who has experience of ecosystem modelling - so long as they have sufficient common ground for collaboration - the conditions for effective modelling of specific ecosystems will exist.

As a first step, one could envisage a strengthening of existing efforts in this field, by establishing effective communication among the different centres currently involved, increasing the facilities and personnel available where these are inadequate, and developing a mutual understanding as to the alternative approaches possible.

In the second place, an extensive training programme could be established which would spread understanding of the systems approach to ecosystems among the personnel in universities and government departments who are concerned with teaching and research in ecology, and with the use and management of natural resources. The training could in part be conducted by instructional teams moving around from country to country, bringing together a group of people for training within their normal surroundings, and making abundant use of local examples; in part, use could be made of existing centres of ecosystem modelling, to which personnel could be brought for periods of intensive training by the staff of the centre.

It is desirable that the training programme should be organized internationally with adequate financial assistance, and that trainees should be exposed to a variety of experience, both in respect of the type of modelling work with which they are associated, and the type of ecosystem modelled. This would imply that the trainee should spend periods of several months in each of three or four centres, where he would benefit from variety both of environment and of modelling experience.

Concurrently, arrangements should be made to assemble - and, where necessary, acquire - the data which will be needed for ecosystem modelling. An inventory of ecosystems (based on classification and mapping on a world-wide scale) would, for instance, be required in order to set priorities and to assess the range of relevance of work in progress. The assistance of WMO would be needed in assembling climatic data from different regions and in filling lacunae that might become evident from the biological point of view.

When training of personnel has reached a suitable stage, steps could be taken to develop at least a dozen new centres for active work in ecosystem modelling. These would need to be associated with well-established universities or research institutes active in the ecological field, where good computer facilities and supporting staff are available together with a wide range of ecological competence. The latter must be emphasized, for interaction between personnel of different background, all contributing to the building of different parts of the same model, is a most important element in systems ecology. These new centres should be located in countries at present lacking experience in this field; some of them should be established in developing countries, provided the requisite computer facilities exist or can be brought into existence.

If these, or similar, steps are taken, it may be anticipated that a period of five or ten years would see the systems approach firmly established in research and teaching in the fields of ecology and the rational use of natural resources throughout the world. In working towards its objectives of understanding how man affects and is affected by the biosphere, and thus of controlling these interactions in whatever ways human welfare demands, the MAB Programme will need, and will have needed to develop, a pool of trained manpower and facilities in all parts of the world.

II. 3 REMOTE SENSING

(Adaptation of a working paper prepared for the first session of the International Co-ordinating Council)

A programme entitled "Man and the Biosphere" brings into juxtaposition two systems having very different orders of magnitude, namely:

Man, a point receiver, if considered as an isolated individual; or a multi-point receiver if we are considering the entirety of the individual observers distributed over the globe; and

the Biosphere, the global system constituted by the spherical shell of our planet, within which life is maintained, with man constituting one of its integral elements, possibly the one introducing the greatest amount of disturbance.

How will man be able to apprehend this global system, and be able to transform the concept of the biosphere into an object fitting into his scientific universe and susceptible to experiment, so that he can acquire knowledge of it and ultimately control it for his own advantage?

The fact is that, in spite of the arsenal of instruments that he is developing to assist the exercise of his senses and to increase their scope and number, the human observer will remain a point receiver in relation to the global system which the biosphere represents for him, and it will not be possible to deduce the information necessary for understanding and controlling this system simply by summing the partial data obtained from different places.

The spontaneous reaction of anyone who is trying to take in a whole system is to step back and view the system as a whole. The system of scientific observation conducted under these conditions has been termed remote sensing; this broad term groups together all the methods which render possible the acquisition of information concerning an observed system, without physical contact and at a distance.

The eye and the ear perform remote sensing naturally, the former within a narrow (visible) band in the electromagnetic spectrum, and the latter within the audible band of acoustic waves. Thanks to this remote sensing, the observer acquires, at a distance, certain information relating to the position and properties of sources of radiation. On account of the natural limitations of these organs, however, the observer obtains only a very small fraction of the information actually available; but many of the sensors and associated instruments nowadays available enable these limitations to be overcome. With the exception of gravity waves, whose existence still has to be investigated, we have at our disposal emitters, receivers and analytical expressions for dealing with emission, reception, measurement and calculation in respect of all types of fields and radiations.

On examining the present situation as regards the technical means that have been developed for pursuing the class of activities known as remote sensing, we find that measurements involving potentials and fields (electric, magnetic, or gravitational) have continued to be dealt with under specialized disciplines (atmospheric potentiometry and inductometry, geomagnetism and gravimetry, to mention only the most important), and that the principal developments of instrumentation have been in the domain of methods utilizing propagated energy (waves or radiations) - above all, electromagnetic energy. The latter is nowadays used for remote sensing over the whole spectrum from

X-rays to decimetre wave lengths, by means of various instruments described briefly below:

Photographic cameras used either with several emulsions or with a single emulsion which simultaneously receive several images transmitted by objectives fitted with different filters (polychrome selection). These photographic techniques permit reception up to about 0.9 micrometres.

Radiometers, spectrometers, multispectral scanners with fixed bands (2 to 24 bands) or wobbulated. These techniques are used for the ultraviolet, for the visible range, and especially for the intra-red (near infra-red, 3 to 5 micrometres and 8 to 15 micrometres bands, these two latter corresponding to two transmission "windows" of the atmosphere).

Passive microwave radiometers and radars of various kinds:

Diffractometers; SLAR imaging radars in multiband and multiple-polarization versions; holographic types (vertical viewing) specially adapted for topographic observations.

These latter techniques, which use microwaves for conveying information, have not yet been fully developed; nevertheless, missions which have been carried out with these instruments have shown the extent of their possibilities:

Observations independent of atmospheric conditions (completely independent for the 1 to 300 millimetres band), permitting work to be continuous in all weathers by day and by night.

Discrimination between different surfaces, not by virtue of emissivities and thermodynamic temperatures (as with infra-red waves) but by virtue of the dielectric constants, whose values vary widely from one material to another in this part of the spectrum, so that even materials having identical emissivities and thermodynamic temperatures exhibit differences. This property has been used successfully for studying confluences of fresh water and sea water by measuring the salinity by remote sensing at 1.42 gigahertz.

Penetration of the signal in depth below the surfaces studied: this property is particularly important for studying the dampness of soils, where the strictly surface value, as indicated by infrared radiometry, has little significance.

Near-universal application: "all-weather" cartography, state of surfaces (study of sea waves and oceanic winds), surveys (of fresh and salt water, minerals, forests, soil dampness), to mention only topics already under study.

It will be noted that infra-red radiometry and microwave radiometry complement one another very effectively. From the possibilities demonstrated by every mission, it can already be predicted that remote sensing by microwaves will become the principal method for collecting information relating to terrestrial resources as soon as the following two steps have been taken:

1. To develop instrumentation meeting the standard requirements for remote sensing missions, which are certainly less severe than the military standards which the existing instruments satisfy; the resulting cost reduction will encourage the use of these devices.

2. To increase our present fragmentary and inadequate knowledge of the physical properties exhibited by inert material, and even more importantly by living organisms, in this part of the electromagnetic spectrum.

Whatever the amount of progress achieved in instrument technology, the essential problem remains one of choice, as in the case, moreover, in all measurement activities, the main questions are:

What information should be collected? How should it be collected? How should it be interpreted? What use should be made of it?

To the above questions we must add a further two which apply more specifically to remote sensing:

When should the information be collected? What degree of detail should be aimed at? This last point must take account of the physical resolving power of the equipment used, and hence must involve a compromise.

These various choices and options are not all of equal importance in remote sensing; two relevant points must be noted:

1. Work done during the last ten years has for the most part related to the development of instruments for collecting data (radiometers, scanners, etc.) and for the automatic processing of data (computers); in consequence, we already have the situation that the available instrumentation, although it has not yet attained its full development, can collect much more information than can be interpreted by the different disciplines involved. From the point of view of economy and efficiency, it is desirable that this imbalance should not be allowed to worsen, and that at least an equal amount of work should be done by the ground teams receiving the remotely sensed data, for the analysis and interpretation of those data relating to their discipline.

2. In setting out to collect the maximum amount of information on the complex system constituted by a zone of the biosphere, remote sensing does not introduce a new discipline, but represents a multidisciplinary collaboration for the production, the calibration and the utilization of instrumentation, for the processing and interpretation of the documents obtained. The latter, which by their nature contain synthesized information, can only be understood after further interpretation by the relevant specialists - geologists, geographers, pedologists, hydrologists, agronomists, forestry specialists, zoologists, botanists, ecologists, bioclimatologists, economists, etc., to name only a few. The specialists in these disciplines should be given a common basic training in remote sensing technology, so that they are all equally capable of using the same documents.

Such an approach is immediately seen to be particularly suitable for the study of the biosphere:

1. On account of its global extension and synthetic character: The biosphere has in fact hitherto been studied "as separate components", by different and distinct groups who isolate from it the part necessary for their special study - plants, animals, soils, etc. Research of this kind "dismantles" the system, so to speak, in order to facilitate the study of each component, or possibly of more or less simplified sub-sets. But however precise our knowledge of a component, it cannot enable us to understand the functioning of the system of which it is a part. On the other hand, a knowledge of the complete system enables us to see each component in its proper place and to understand its characteristics better.

By making it possible to obtain global observations on a system, remote sensing enables a synoptic knowledge of the system to be built up, in which however each element of the system remains recognizable, thanks to its "signature" (see 2 below).

It should nevertheless be noted that while preliminary research is needed at all stages (instruments, knowledge of materials, interactions, etc.) before remote sensing equipment can be made operational, nevertheless remote sensing itself, at least in its present state of technological development, does not constitute a research method, but essentially a reconnaissance method.

Leaving aside certain very particular cases where it has been found possible to make an absolute determination of the significance of the signals collected (characteristic radiations from elementary materials), it is always the responsibility of the laboratory, or rather the ground team, to give the actual significance of the signals analysed ("ground-truth"). These activities, essential for the proper interpretation of the data, may require only simple equipment (a simple measurement of the temperature on the ground may constitute a decisive piece of information if it is synchronized with the passage of the aeroplane or satellite and transmitted in good time to the data-centralizing systems). A global study of the biosphere by remote sensing can thus benefit substantially from the collaboration of very small teams distributed round the world at selected representative sites integrated into a data-transmission network (utilization of telephone networks, of wireless ground waves, or of data-collecting and transmitting satellites). It has been suggested that there should be ten million of such sites available round the world during the mission of the ERTS A and B satellites.

2. Again, remote sensing permits non-destructive analysis: The specific nature of the interaction between energy and matter is known; every element and every object exhibit the evidence of their peculiar characteristics (temperature, composition, structure, etc.) by the radiation which they emit, or which they relay or reflect after reception, in the form of well-defined radiation bands or lines. It is precisely the specificity of these interactions which provides the basis of the techniques used in laboratory analysis (radiometry, spectrometry, spectrophotometry, etc.).

For studying a given element, it is usually sufficient to examine only an appropriately selected part of this "signature"; it will be noticed, for example, that all the principal molecular pollutants have an electromagnetic spectrum exhibiting at least one strong line in the 3 to 15 micrometres band. It is within this band that two of the principal transmission "windows" of the atmosphere are located (at 3.5 to 5 and 8 to 14 micrometres). Hence, by using infra-red spectrographs and scanners sensitive within these bands, it is possible to proceed by remote sensing, without sampling or destructive testing, to make analyses and quantitative evaluations of elements such as those naturally present in the atmosphere, pollutants, etc., and to become informed about their distribution and evolution.

The concept of the "signature" has been extended to apply to fairly complex global aggregates, such as fields of cereals, forests, alluvial deposits, fishery banks, etc., and a number of investigations have shown that the analysis can reliably be used for identifying species and recognizing their state; activities pursued in this domain have made it possible to take stock rapidly, and over large areas, of natural and cultivated resources; and to track down diseases, attacks by parasites, irrigation deficiencies, etc., at an early stage. These results are of great importance in relation to the management of the biosphere's natural resources and their utilization in an economic and rational manner.

It should however be noted that when remote sensing is employed for purposes of analysis, the decoding of the signal carrying the "signature" becomes the more complicated the greater the distance to the receiver; the latter actually receives the sum of the "signatures" emanating:

from the source which, in the case of passive methods, is the sun or thermal radiation proper;
from the re-emitter or reflector under consideration (the particular object under study);
from the media traversed by the signal (usually, the atmosphere).

Here it is worth while emphasizing again the clear advantage of microwave radar methods (SLAR and holographic), whose resolution is not range-dependent at aeronautical altitudes, and whose complete independence (see above) of atmospheric conditions means that the latter have no effect on the signal transmitted.

It is as a result of these various multiple interactions that, in the present state of our knowledge, the measurements obtained by remote sensing in most cases lose the absolute character which these methods might afford when practised in the laboratory (the essential problem of the "ground-truth").

3. The high speed of remote sensing: The

rapid evolution of the technology of sensors during the last decade has made possible the production of types combining a high cut-off frequency (over one megahertz) with very high sensitivity. It has thus become possible to instal measuring instruments on fast means of transport (aeroplanes or satellites) and to obtain pictures very quickly by television or by linear scanning of the field of view, even for distances of the order of 400,000 km.

The rapidity with which information is obtained by these methods, and the fact that it can be repeated, either at any required time, when working with airborne platforms, or automatically on interrogation when satellites are used, constitute particularly valuable features for studying a system such as the biosphere, all of whose elements are in continuous evolution at more or less rapid rates (e.g. evolution of populations, spread of deserts, increase of pollution migrations, etc.).

The following examples illustrate the high speed of the observations:

With the existing instruments, the smallest type of propeller-type aircraft, flying at 5,000 metres above ground level, can collect data from a ground area of about 1,000 km^2 in one hour.

Larger aircraft, flying at 10,000 metres, can attain a coverage of 25,000 km^2 per hour. This rate can moreover be increased by the full use of the time, in the case of microwave radar observations (see above).

The ERTS-A satellite (planned to be launched in 1972) in an orbit of 912 kilometres (492.35 nm.), will effect complete coverage of the globe every 18 days, in 251 revolutions.

It is also possible to envisage, for particular purposes not demanding a very high resolution, geostationary satellites at an altitude of 36,000 kilometres, capable of providing at precise intervals of about one hour the information from a given point on the globe.

We may draw attention here to the important contribution made by the "Nimbus" meteorological satellites to our knowledge of the state and of the evolution of cloud masses and of bodies of snow and ice round the world; and we may point out the possibility of operating the ERTS A and B satellites in the same way.

In cases where the final document is an image (photographic techniques; CRT reproduction of recordings made from television, from scanners and from imaging radars; facsimiles supplied by the receiving stations of meteorological satellites), the interpretation, at least in the first stage, can be effected with simple means (visual presentation on luminous table, densimetry); however, it will be obvious that when the activity is intensive, so that a very large amount of information is obtained in a very short time, computer processing of the data is essential to derive the full benefit of this high-speed operation. However, we must not be misled into regarding this automatic processing as anything more than a method for accelerating the handling of the data collected. The computer cannot take the place of the observer-in-charge for interpreting the observations, or draw any conclusions other than those derived by the human observer as a result of the programme carefully established by him for sorting, combining and evaluating the data. The size of the automatic computing installation should of course be adapted to suit the capacity of the systems employed for collecting the data. Consideration of the computing power required for processing the data received from satellites ERTS A and B indicates that just a few ground receiving stations would be provided, and these would redistribute the received data after first-stage processing.

4. Capacity for generalization: Remote sensing makes it possible to follow up investigations conducted in the laboratory or at localized experimental plots, so that the knowledge (e.g. inventory, thematic cartography) acquired for a particular "point" can be generalized for a whole region. In order to determine the "ground-truth" which is essential for ensuring the correct interpretation of the received data, it is necessary to select several reference points whose characteristics are completely known; it may also prove necessary to conduct supplementary ground measurements in regions where there is ambiguity in the interpretation of the data.

Remote sensing is the only method at our disposal capable of effecting this generalization in a time compatible with the evolution of the constituent elements of the biosphere. Satellites, whether "for terrestrial resources" (equipped with sensors) or "for collection of data" (teletransmission satellites) provide the only means capable of supplying information practically simultaneously from all parts of the globe.

It is highly probable that by means of this type of instrumentation we shall, step by step, attain the possibility of making a complete study of the biosphere, including the description of its present state and its evolution. However, the lesson to be learnt from a decade of activity aimed in this direction is that before we can conduct such a global study by means of external observations, we need to have in advance a thorough understanding of the correlations existing between the various elements of the observed system and the apparent "signatures" which the satellite, external to the system, may receive.

Hence, at the same time, a large amount of work has to be done within the system itself, in order that the rôle of systematic monitoring, for which satellites are more particularly suited, can be progressively transferred to them.

<u>In conclusion</u>

The effectiveness of such a programme depends very much on international collaboration:

1. For the collection of data which, for the particular purposes of remote sensing, are intended to be generalized as widely as possible. Even very small teams have a part to play in this activity, within the collecting network, in which the link constituted by the "ground-truth" will for a long time yet remain an essential reference element.

2. For the compilation, standardization and dissemination of the information collected, and the "reliability rate" which it offers. The quantity of information which is to be expected, and the desirable speed of handling and redistributing it, call for the most modern equipment for automatic information handling. In fact, the development of a methodology appropriate to these methods will depend to a great extent on the satisfactory handling of the confirmed results. It can thus already be envisaged that these methods and the devices needed to implement them will evolve during the period of the MAB Programme itself.

Finally, it is necessary to point out the dangers to which the biosphere is exposed by the very effectiveness of these methods. The combination of efficient modern methods of harvesting and marketing with the high speed of location made possible by remote sensing introduces the risk that certain natural resources in great demand (e. g. shoals of fish, tropical woods, etc.) may rapidly become exhausted. It would appear to be absolutely necessary that, at the same time, a plan for the exploitation of the biosphere should be instituted and implemented, which would take into account the production and regeneration rates of these various elements. These data, which are essential for a well-balanced management of the biosphere, are in fact included among those that can be supplied by continuous, routine remote sensing, using satellites.

At the present time, when there are signs here and there of the exhaustion of natural resources, while at the same time demands are increasing rapidly, it is of the very greatest importance to ensure the most enlightened management of these resources. The first step consists in drawing up a precise inventory of them, and following its evolution. Remote sensing methods using airborne or satellite-borne equipment should provide the best way of obtaining the information essential for this purpose.

A simulation study, making use of mathematical and physical models, could provide the means for integrating the data obtained and for arriving by successive approximations at the magnitudes which have a determining influence on the equilibrium of the system:

existing biomasses available at the various levels of consumption (primary consumer, secondary, etc.);

regeneration rate of these biomasses and authorized rate of consumption at each level.

ANNEX III

RESOLUTION 2.313 ADOPTED BY THE GENERAL CONFERENCE OF UNESCO AT ITS SIXTEENTH SESSION

2.313 The General Conference,

Bearing in mind the recommendations of the Intergovernmental Conference of Experts on the Scientific Basis for the Rational Use and Conservation of the Resources of the Biosphere, held in September 1968,

Recalling resolution 2.313 adopted at its own fifteenth session,

Considering that there is a pressing need for bold international action concerning the scientific aspects of the rational use and conservation of the natural resources of the biosphere and the improvement of the global relationship between man and his environment,

Stressing the place which these problems should hold in education and culture,

Keeping in view the necessity, on the one hand, to accelerate the economic progress of developing nations and, on the other hand, to keep under constant review the technological developments which may contribute to the degradation of the environment,

Having taken note of the report of the Director-General (document 16 C/78) on this matter and of the proposals made therein,

1. Decides to launch a long-term intergovernmental and interdisciplinary programme on Man and the Biosphere focusing on the general study of the structure and functioning of the biosphere and its ecological regions, on the systematic observation of the changes brought about by man in the biosphere and its resources, on the study of the overall effects of these changes upon the human species itself, and on the education and information to be provided on these subjects;

2. Wishes that this Programme be carried out in close co-operation with the United Nations and the other organizations of the United Nations system concerned, with due regard to the views of the Administrative Committee on Co-ordination, as well as with the competent international non-governmental organizations;

3. Establishes, in accordance with the statutes annexed to the present resolution, an International Co-ordinating Council responsible, within Unesco's fields of competence, for planning this programme, defining its priorities, supervising its execution and making any necessary proposals for co-ordinating this Programme with those conducted by all the international organizations concerned;

4. Selects the following Member States to be members of the International Co-ordinating Council in 1971-1972:(1)

Argentina	Brazil	Chile
Australia	Canada	Czechoslovakia

(1) The Member States listed in this paragraph were elected on the report of the Nominations Committee at the thirty-first plenary meeting, on 6 November 1970.

Arab Republic of Egypt	Iraq	Sweden
France	Italy	Uganda
Federal Republic of Germany	Japan	Union of Soviet Socialist Republics
India	Malaysia	United Kingdom of Great Britain and Northern Ireland
Indonesia	Netherlands	United States of America
Iran	New Zealand	
	Nigeria	
	Romania	

5. Recommends that the International Co-ordinating Council, taking into account the views that the Member States may submit thereon, consider the proposals made by the Director-General in document 16 C/78 concerning the Programme;

6. Invites Member States to establish National Committees for ensuring their full participation in this Programme;

7. Intends to make a further review of the situation at its seventeenth session, in the light of the results of the United Nations Conference on the Human Environment (Stockholm, 1972) and of discussions pertaining thereto in the General Assembly.

ANNEX IV

STATUTES OF THE INTERNATIONAL CO-ORDINATING COUNCIL OF THE PROGRAMME ON MAN AND THE BIOSPHERE

Article I

An International Co-ordinating Council of the Programme on Man and Biosphere (hereinafter called "Council") is hereby set up within the United Nations Educational, Scientific and Cultural Organization.

Article II

1. The Council shall be composed of twenty-five Member States of the United Nations Educational, Scientific and Cultural Organization, elected by the General Conference at each of its ordinary sessions, taking due account of equitable geographical distribution, of the need to ensure appropriate rotation, of the representativeness of these States from the ecological viewpoint in the various continents, and of the importance of their scientific contribution to the international programme.
2. Members of the Council shall be immediately eligible for re-election.
3. The Council may make recommendations concerning its own membership to the General Conference.
4. The persons appointed by Member States as their representatives on the Council shall preferably be experts in the field covered by the Programme and chosen from among those persons who are playing a major part in the implementation of the activities related to the Programme in the said Member States.

Article III

1. The Council shall normally meet in plenary session once every two years. Extraordinary sessions may be convened under conditions specified in the Rules of Procedure.
2. Each Council member shall have one vote, but it may send as many experts or advisers as it deems necessary to sessions of the Council.
3. The Council shall adopt its own Rules of Procedure.

Article IV

1. The Council shall be responsible for guiding and supervising the planning and the implementation of the Programme on Man and the Biosphere, for studying proposals concerning development and modifications of this Programme, for recommending scientific projects of interest to all or to a large number of countries, and assessing priorities among such projects, for co-ordinating international co-operation of Member States in the framework of the Programme, for assisting in the development of national and regional projects related to the Programme, and for taking any practical or scientific measures that may be required for the successful implementation of the Programme.
2. In carrying out its activities, the Council shall make full use of the facilities offered by the agreements or working arrangements between Unesco and the other intergovernmental organizations mentioned under Article VII, paragraph 2.
3. The Council may consult on scientific questions all appropriate international non-governmental organizations with which Unesco maintains official relations. The International Council of Scientific Unions (ICSU) and its affiliate unions and associations, and the International Union for the Conservation of Nature and Natural Resources (IUCN) may give advice to the Council on matters of a scientific or technical character.
4. The Council shall, wherever necessary, attempt to co-ordinate the Programme on Man and the Biosphere with other international scientific programmes.

Article V

1. The Council may set up ad hoc committees for the study of specific problems. Membership of such ad hoc committees shall also be open to Member States of Unesco which are not represented in the Council.
2. The Council may delegate to any such committee the powers that it may need in regard

to the programme for which it has been set up.

3. Taking into account other relevant international activities, the Council may establish as required working groups of specialists to examine certain aspects of the Programme. These working groups, whose members shall serve in a personal capacity, may include nationals of Member States of Unesco which are not represented on the Council.

Article VI

1. At the beginning of its first session, the Council shall elect a chairman and four vice-chairmen; these shall form the Council's Bureau.
2. The Bureau shall discharge such duties as the Council may lay upon it.
3. Meetings of the Bureau may be convened in between meetings of the Council, at the request of the Council itself, of the Director-General of Unesco or of any one member of the said Bureau.
4. The Council shall elect a new Bureau whenever its own membership is changed by the General Conference in accordance with Article II, above.

Article VII

1. Representatives of Member States and Associate Members of Unesco which are not members of the Council may nevertheless attend, as observers, meetings of the Council and its committees.
2. Representatives of the United Nations, the United Nations Educational, Scientific and Cultural Organizations, the Food and Agriculture Organization of the United Nations, the World Health Organization and the World Meteorogical Organization may take part, without the right to vote, in all meetings of the Council of its committees and of its working groups.
3. Representatives of the International Council of Scientific Unions and the International Union for the Conservation of Nature and Natural Resources may take part, without the right to vote, in all meetings of the Council, of its committees and of its working groups.
4. The Council shall determine the conditions under which other international governmental or non-governmental organizations, and in particular the International Atomic Energy Agency and Intergovernmental Maritime Consultative Organization, will be invited to attend its meetings, without the right to vote, whenever questions of common interest are discussed.

Article VIII

1. The secretariat of the Council shall be provided by the Director-General of the United Nations Educational, Scientific and Cultural Organization, who shall place at the Council's disposal the staff and other means required for its operation. Staff members of the other organizations mentioned in Article VII, paragraph 2, above may be assigned to the secretariat by agreement with the said organizations.
2. The secretariat shall provide the necessary services for the sessions of the Council and meetings of its Bureau, committees and working groups. Arrangements may be made with the other organizations mentioned in Article VII, paragraph 2, for providing such services to particular working groups of the Council.
3. The secrerariat shall take any day-to-day measures required in order to co-ordinate the execution of the international programmes recommended by the Council; it shall fix the date of the Council's sessions in accordance with the Bureau's instructions, and shall take all steps required to convene such sessions.
4. The secretariat shall assemble all proposals sent in by members of the Council, other Member States of Unesco and the international organizations concerned with regard to the formulation of the international projects under the Programme and shall prepare them for examination by the Council; it shall maintain liaison with the national committees established by Member States for the execution of the Programme in accordance with the invitation contained in resolution 2.313 adopted by the General Conference at its sixteenth session, and inform them of the Council's recommendations.
5. In addition to the services to be rendered to the Council, the secretariat shall co-operate closely with the secretariats of the international governmental and non-governmental organizations mentioned in Article VII, paragraphs 2 and 3 above; it shall for this purpose take part in intersecretariat co-ordination meetings as necessary.

Article IX

1. The international programmes of observation and investigation, recommended by the Council to Member States for concerted action on their part, shall be financed by the participating Member States, according to the commitments which each State is willing to make. The Council may, however, make recommendations to the United Nations Educational, Scientific and Cultural Organization and to the other organizations mentioned in Article VII, paragraphs 2 and 3 above, concerning assistance to Member States for the development of environmental observation and research or the implementation of some particular aspect of the Programme. If the said organizations accept such recommendations and if the Member States concerned

signify their agreement, these organizations shall undertake to finance the related activities in accordance with the provisions of their respective constitutions and regulations.

2. Member States shall bear the expense of participation of their representatives in sessions of the Council and its committees. The running expenses of the Council and its subsidiary organs shall be financed from funds appropriated for this purpose by the General Conference of the United Nations Educational, Scientific and Cultural Organization as well as from such additional resources as may be made available by other organizations of the United Nations System.
3. Voluntary contributions may be accepted and established as trust funds in accordance with the Financial Regulations of the United Nations Educational, Scientific and Cultural Organization and administered by the Director-General of that Organization. The Council shall make recommendations to the Director-General on the allocation of such contributions for international projects under the Programme.

Article X

The Council shall submit reports on its activities to the General Conference of the United Nations Educational, Scientific and Cultural Organization at each of its ordinary sessions. These reports shall be communicated for information to the other international organizations mentioned in Article VII, paragraphs 2 and 3 above.

ANNEX V

RULES OF PROCEDURE OF THE INTERNATIONAL CO-ORDINATING COUNCIL OF THE PROGRAMME ON MAN AND THE BIOSPHERE

I. MEMBERSHIP

(1) The International Co-ordinating Council of the Programme on Man and the Biosphere (hereinafter called the Council) is composed of 25 Member States of Unesco, selected by the General Conference at each of its ordinary sessions in accordance with Article 2 of the Statutes of the Council.

(2) Each State member of the Council shall notify the Secretariat of Unesco of the names of its designated representative as well as of advisers and experts.

II. SESSIONS

1. Date and place

(1) The first session of the Council shall be convened by the Director-General of Unesco. The place and date of that session shall be communicated in advance to all interested Member States and organizations.

(2) Other sessions shall be convened by the Secretariat of the Council in accordance with the instructions of the Bureau of the Council.

(3) The Council shall normally meet at the Headquarters of Unesco. It may meet elsewhere if so decided by a majority of the members.

III. AGENDA

2. Provisional agenda

(1) The provisional agenda of the first session of the Council shall be prepared by the Director-General of Unesco.

(2) The provisional agenda of the following sessions of the Council shall be prepared by the Secretariat of the Council in consultation with the members of the Bureau.

(3) The provisional agenda shall be communicated to the members of the Council at least two months before the opening of each session.

(4) The provisional agenda shall be communicated at the same time to Member States and Associate Members of Unesco which are not members of the Council as well as to the United Nations, FAO, WHO, the UCN and ICSU.

(5) The provisional agenda of a session of the Council shall include:

all items whose inclusion has been decided by the Council;

all items proposed by States members of the Council;

all items proposed by the United Nations or by its agencies;

all items proposed by the Director-General of Unesco.

3. Adoption of the agenda

At the beginning of each session, the Council shall adopt the agenda for that session.

4. Amendments, deletions and new items

The Council may, during a session, modify the order of items of the agenda or add or delete items. A majority of two-thirds shall be required for the addition or deletion of items during a session.

IV. OFFICERS

5. Election of chairman and vice-chairmen

(1) At the beginning of its first session, the Council shall elect a chairman and four vice-chairmen; these shall form the Council's Bureau.

(2) Thereafter the chairman and the vice-chairmen shall be elected in accordance with Article 6, paragraph 4 of the Statutes of the Council.

(3) Members of the Bureau are eligible for re-election.

6. General powers of the chairman

(1) In addition to exercising the powers conferred upon him elsewhere by these rules, the chairman shall have the following powers: he shall declare the opening and closing of meetings, direct the discussions, ensure observance of these rules, accord the right to speak, put questions to the vote and announce decisions. He shall rule on points of order and subject to these rules shall control the proceedings and the maintenance of order.

(2) If the chairman ceases to represent a State member of the Council or is so incapacitated that he can no longer hold office, a vice-chairman

shall become chairman for the unexpired portion of the term of office. If that vice-chairman also ceases to represent a State member of the Council or is so incapacitated that he can no longer hold office, another vice-chairman shall become chairman for the unexpired portion of the term of office.

7. Functions of vice-chairmen

In the absence of the chairman during a session, his functions shall be exercised in turn by the vice-chairmen.

V. COMMITTEES AND WORKING GROUPS

8. Ad hoc committees

(1) Ad hoc committees set up by the Council in accordance with Article 5 of the Statutes of the Council shall meet in accordance with the decisions of the Council or of the Bureau.

(2) These ad hoc committees shall elect their own chairman, vice-chairmen and, if necessary, their own rapporteur.

9. Working groups

(1) Working groups set up by the Council in accordance with Article 5 of the Statutes of the Council shall meet in accordance with the decisions of the Council or of the Bureau.

(2) These working groups shall elect their own chairman, vice-chairmen and, if necessary, their own rapporteur.

10. Rules of Procedure

These rules of procedure shall apply to the proceedings of committees and working groups unless the Council decides otherwise.

VI. SECRETARIAT

(1) The Director-General shall place at the disposal of the Council a member of the Secretariat of Unesco who shall act as Secretary of the Council and the staff and other means required for its operation.

(2) The Secretary of the Council shall attend all meetings of the Council and the Bureau.

(3) The Secretary or his representative may make oral as well as written statements to the Council, its ad hoc committees and working groups and to the Bureau concerning any question under consideration.

(4) Staff members of the other organizations mentioned in Article 7, paragraph 2, of the Statutes of the Council may be assigned to the Secretariat in accordance with Article 8, paragraph 1, of these Statutes.

VII. LANGUAGES

11. Working languages

English, French, Russian and Spanish shall be the working languages of the Council.

12. Use of other languages

Any representative may make a speech in a language other than the working languages currently in use for a particular session of the Council of a committee or a working group on the condition that he provides for the interpretation of his speech into one or the other of the said working languages.

VIII. REPORTS AND DOCUMENTS

13. Reports

(1) The Secretariat shall submit a report to each session of the Council.

(2) The Council shall submit reports on its activities to each ordinary session of the General Conference of Unesco.

(3) Copies of these reports shall be circulated by the Director-General of Unesco in accordance with Article 10 of the Statutes of the Council.

14. Working documents

The working documents of each session of the Council shall, as a rule, be communicated to the members one month before the opening of each session.

IX. MEETINGS

15. Quorum

(1) A simple majority of the States members of the Council shall constitute a quorum.

(2) At meetings of subsidiary bodies of the Council a quorum shall be constituted by a simple majority of the States members of the Council which are members of the body in question.

16. Publicity of meetings

All meetings of the Council shall be open to the public unless the Council decides otherwise.

X. CONDUCT OF BUSINESS

17. Right to speak

Experts and observers may, with the authorization of the chairman, make oral or written statements before the Council and its committees.

18. Order of speeches

The chairman shall call upon speakers in the order in which they have expressed the desire to speak.

19. Time-limit on speeches

The Council may limit the time to be allowed to each speaker.

20. Points of order

During the discussion on any matter, a representative may at any time raise a point of order and the point of order shall be forthwith decided by the chairman. Any representative may appeal against the ruling of the chairman which can only be overruled by a majority of the members present and voting. A representative may not in raising a point of order speak on the substance of the matter under discussion.

21. Suspension, adjournment, closure

Any representative may, at any time, propose the suspension, adjournment or closure of a meeting or of a debate. Such a motion shall be put to the vote immediately. The order of priority of such motions shall be as follows:

(a) suspension of the meeting;
(b) adjournment of the meeting;
(c) adjournment of the debate on the item under discussion;
(d) closure of the debate on the item under discussion.

XI. VOTING

22. Voting rights

Each State member of the Council shall have one vote.

23. Simple majority

(1) Unless otherwise provided in these rules, decisions shall be taken by a simple majority of the members present and voting.

(2) For the purpose of these rules, the phrase "members present and voting" means members casting an affirmative or negative vote. Members who abstain from voting are considered as not voting.

24. Show of hands and roll-call

Voting shall normally be by show of hands, except that any member may request a roll-call. The vote and abstention of each member participating in a roll-call shall be inserted in the report.

25. Voting on amendments

(1) When an amendment to a proposal is moved the amendment shall be voted on first.

(2) When two or more amendments to a proposal are moved, the Council shall first vote on the amendment deemed by the chairman furthest removed from the original proposal and then on the amendment next furthest therefrom, and so on, until all amendments have been put to a vote. If one or more amendments are adopted, the amended proposal shall then be voted on. If no amendment is adopted, the proposal shall be put to the vote on its original form.

(3) A motion is considered an amendment to a proposal if it adds to, deletes from or revises part of that proposal.

26. Secret ballot

All elections shall be decided by secret ballot unless, in the absence of objections, the Council decides otherwise.

27. Equally divided votes

If a vote is equally divided on matters other than elections, the proposal shall be regarded as rejected.

XII. SPECIAL PROCEDURES

28. Special consultation by correspondence

Should the approval of the Council be required for measures of exceptional urgence and importance while the Council is not in session, the chairman may, by means of the secretariat, consult the members by correspondence. The proposed measure shall be adopted if it is approved by two-thirds of the members.

XIII. AMENDMENT

29. Amendment

These rules of procedure, except when they reproduce provisions of the Council Statutes or decisions of the General Conference, may be amended by a decision of the Council taken by a simple majority of the members present and voting, provided that the proposal for amendment has been placed on the agenda.

30. Suspension

Suspension of any of these rules shall require a two-thirds majority of the members present and voting.

ANNEXE/ANNEX/ANEXO/ПРИЛОЖЕНИЕ VI

LISTE DES PARTICIPANTS/LIST OF PARTICIPANTS
LISTA DE PARTICIPANTES/СПИСОК УЧАСТНИКОВ

Names and titles in the following lists are reproduced as handed in to the Secretariat by the delegations concerned. Countries are shown in the French alphabetical order. (An asterisk indicates the Head of the delegation).

Les noms et titres qui figurent dans les listes ci-après sont reproduits dans la forme où ils ont été communiqués au Secrétariat par les délégations intéressées. Les pays sont mentionnés dans l'ordre alphabétique français. (Un astérisque indique le chef de délégation).

Los nombres y títulos que figuran en las listas siguientes se reproducen en la forma en que las delegaciones interesadas los han communicado a la Secretaría. Los países se mencionan en el orden alfabético francés. (Un asterisco indica el jefe de la delegación).

Фамилии и звания, указанные в нижеприведенном списке, воспроизводятся в том виде в каком они были представлены Секретариату соответствующими делегациями. Страны перечислены в порядке французского алфавита. (Звездочка указывает главу делегации).

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A stylized "ankh", the ancient Egyptian sign for life, has been incorporated into the symbol of the Programme on Man and the Biosphere (MAB).